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IGCSE

Information and Communication Technology

Graham Brown and David Watson

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Contents

Introduction

Aims

This book has been written to provide the knowledge, understanding and practical skills that you need for the Cambridge IGCSE in Information and Communication Technology. This book, together with the accompanying CD and image for scanning, provides:

- practice examination questions for the theory elements of the course
- practice tasks which offer guidance on how to answer questions for the practical parts of the course
- activities which allow students practice in answering questions for the practical parts of the course
- source data files for the tasks and activities
- hints and tips for the practical papers
- suggestions for possible teaching methods.

Although it has been written with the CIE syllabus in mind, it can also be used as a useful reference text for other practical ICT qualifications at GCSE and other equivalent Level 2 courses.

Using the book

The text is in 16 chapters. Although it is possible that some elements of the practical chapters may be examined in the theory question papers, and vice versa, the sections for the theory work are in Chapters 1–8 and the sections for the practical work in Chapters 9–16.

Examination questions

For the theory section, there are examination-style questions on the CD, together with model answers, all in portable document format (.pdf). For the practical section, the examination-style questions appear as activities in the book, with the model answers on the CD. Two practice examination papers also appear on the CD.

Colour codes and symbols used

Throughout the book there are a number of colours and symbols used. Key presses are shown as <Enter>, but be careful with Chapter 15, where html codes are also shown in angled brackets, like this <html>. Different sections of text are in the following styles.

Tasks

These are examination-style questions in the practical section (which often include the use of source files from the CD for the practical tasks) that are answered within the chapter. The text demonstrates the techniques used to solve the task and gives some example answers. These provide easy-to-follow step-by-step instructions, so that practical skills are developed alongside the knowledge and understanding.

Activities

These are examination-style questions in the practical section, usually at the end of a chapter or section for the students to answer. These often include the use of source files from the CD. Model answers for each activity are available in portable document format (.pdf) on the CD.

Exercises

In the theory section, these are short exercises for the students to complete in order to confirm their understanding of the concepts covered in a section or chapter.

Hints

These give hints, tips, shortcuts and advice on examination techniques.

```
HTML markup
All html markup appears in a blue,
proportionally spaced font.

Cascading stylesheets
All cascading stylesheet markup
appears in a red proportionally
spaced font.
```

Text colours

Some words or phrases within the text are printed in red. Definitions of these terms can be found in the glossary.

In the practical section, words that appear in **blue** indicate an action or location found within the software package, for example 'Select the **Home** tab.'

In the database sections of the book, words in [illegible] show field names.

Words in **green** show the functions or formulae entered into the cell of a spreadsheet, for example a cell may contain the function **=SUM(B2:B12)**.

Hardware and software used

The practical elements of the examinations can be undertaken on any hardware platform and using any appropriate software packages. For the purposes of this book, we have needed to choose specific software packages, but the functionality of many other packages is very similar. Many of the skills demonstrated in Chapters 9 to 16 are transferable and can be adapted for other hardware and software platforms.

All the tasks and activities within the practical chapters have therefore been created using a PC platform with *Microsoft Windows Vista* operating system and include the use of *Notepad*. Independent packages used for the practical sections include packages from *Microsoft Office Professional Edition 2007*, including *Word*, *Excel*, *Access* and *PowerPoint*. *Internet Explorer* has been used as the web browser and *Windows Live Mail* as a web-based email editor.

For the website authoring section of the book (Chapter 15), all work has been produced in html code without the use of a WYSIWYG package. Although you may have a WYSIWYG package available and may wish to allow students to use this, it is important to realise that they are expected to have knowledge of underlying HTML and cascading stylesheet code. All html written within this chapter is written in HTML version 4.01 strict, and are W3C validated (although the Doctype statements have been removed so as to avoid confusing students). All cascading stylesheets used have been W3C validated.

Using the source image

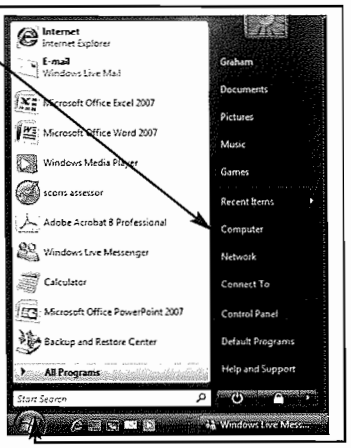
You have been provided with a source image which can be scanned when attempting Activity 10b in Chapter 10. This can be found at the very end of the book, after the index.

Using source files

Source files can be found on the CD and will need to be copied onto your local machine or network drive in order to use them. Copy them and give them read/write access. This is essential to ensure that you can use some of the file types included on the CD. For example, you cannot create queries or reports in *Access* when working from the CD. The CD will contain all source files in a series of sub-folders, one for each of the practical chapters.

PC users

From the **Start** button, select the **Computer** option and locate the CD drive, which may be called drive D: or E:. For the purposes of this section, we will assume that it is called drive E:. If your machine has a different drive for the CD letter, adapt these instructions accordingly. Locate the **Chapter source files** folder, which can be found at **E:\Resources\Chapter source files**. To locate an individual file, such as the image SNOWBALL.JPG used in Chapter 10, use the path **E:\Resources\Chapter source files\Chapter 10\Snowball.jpg**.



It may be better to copy the contents of this folder into a new folder on your local machine or network drive. Open each file as you wish to use it. Select the **Office** button, and then **Save As...** to save a new copy with an amended filename. You may need to change the file permissions of these files to read/write to enable you work on them; however, check with your network administrator before attempting to make these changes.

MAC users

Double click on the CD icon on the desktop. Use *Finder* to navigate to the location for the new folder, then create a new folder (<Apple>+<Shift>+<N>). With *Finder*, choose the CD and select all files (<Apple>+<A>) and copy them (<Apple>+<C>). Go to the new folder using *Finder* and paste the files (<Apple>+<V>).

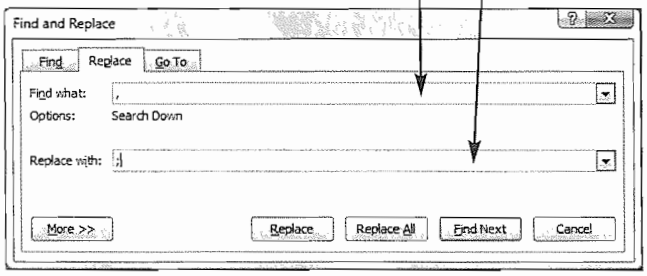
Changing the source files to match your regional settings

Before attempting any of these processes, back up all source files. The source .csv (comma separated value) files supplied on the CD have commas as separators between fields and full stops within currency values. If your regional settings for these values are different to these (for example, if you use commas within currency values rather than full stops and your software settings require you to use semicolons for separators between fields), then the source data files will need to be edited for use with the regional settings for your software. This process may be required to convert the source data files before the start of the practical examinations. You can do this process in many packages, but the easiest (at this level) is *Word*. Open the .csv file in *Word* using the **Office** button and **Open**. Select the file from the list and click on Open. This will open the file, which will look similar to this.

```
Who manufactured the car?,Model,Colour,Price that we bought the car
for,Price that we will sell the car for,Year,Extras,Does the car need
cleaning?
TVR,Tuscan,Black,18000,20305,2006,Alloy Wheels   Air Conditioning,N
Mercedes,C200,Silver,4995,5995,2003,Air Conditioning,N
Toyota,MR2 roadster,Electric blue,13995,15895,2005,Leather Seats   Air
Conditioning,N
```

Select the **Home** tab, then the **Editing** section followed by the **Replace** icon.

Enter a , (comma) into the **Find what:** box and a ; (semicolon) into the **Replace with:** box, then click on Replace All.

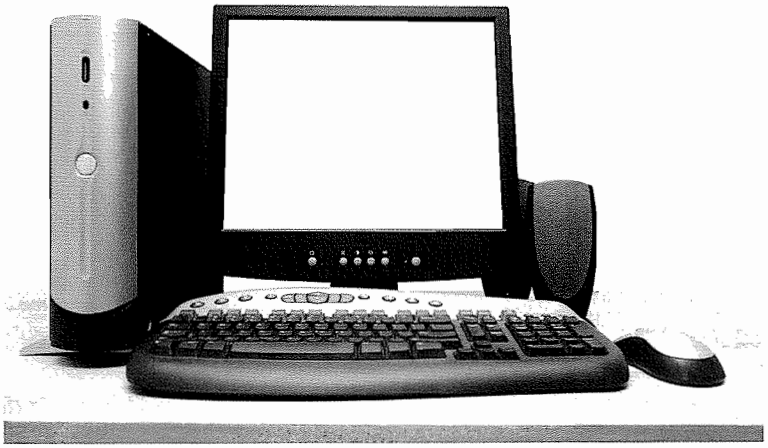


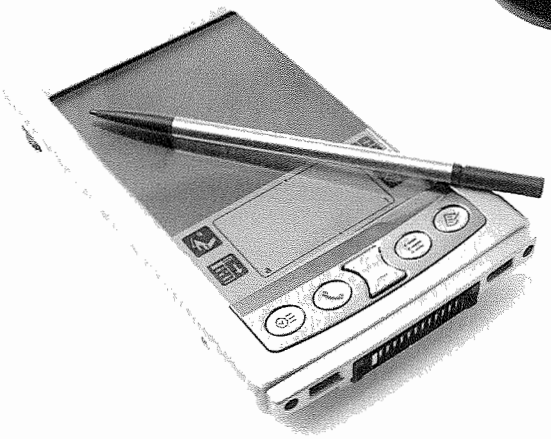
Repeat this process, replacing a . (full stop) with a , (comma). All the characters will have been replaced within the file like this.

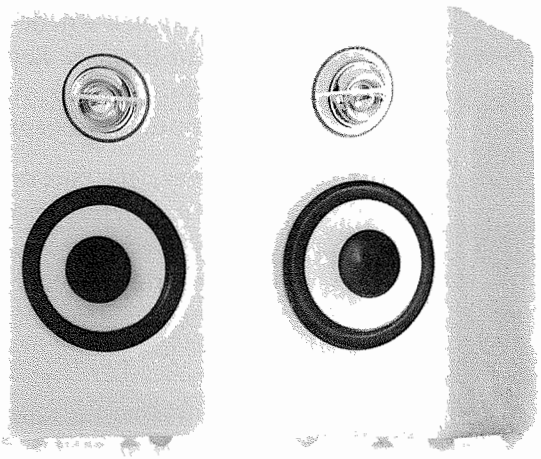
```
Who manufactured the car?;Model;Colour;Price that we bought the car
for;Price that we will sell the car for;Year;Extras;Does the car need
cleaning?
TVR;Tuscan;Black;18000;20305;2006;Alloy Wheels   Air Conditioning;N
Mercedes;C200;Silver;4995;5995;2003;Air Conditioning;N
Toyota;MR2 roadster;Electric blue;13995;15895;2005;Leather Seats   Air
Conditioning;N
```

Save the file with the same file name using the **Office** button and **Save**. This will ensure that the file is saved in .csv format.

Part 1







CHAPTER 1

Types and components of computer systems

In this chapter you will learn about:

- hardware
- software
- the main components of a computer system
- operating systems:
  - graphical user interface (GUI)
  - command line interface (CLI)
- different types of computer systems.

1.1 Hardware and software

Computer systems are now commonplace in every part of our daily life. This chapter introduces the basic components that make up these computer systems; most of these will be described in much greater depth in later chapters. Comparing books with computers is a good analogy: the actual pages and the ink used on the pages are equivalent to the hardware used to make up these computers; the words written on these pages are equivalent to the software. Without the words, the book is useless. Similarly, without software, computers would be of little use to any of us.

Hardware is a general term for the physical components that make up a computer system, for example keyboard, mouse, monitor, processor, circuit board and so on.

Software is a general term for the programs that control the computer system. There are two types of software:

- **systems software**: programs that allow the hardware to run properly, e.g. operating systems
- **applications software**: programs that allow the user to do specific tasks, e.g. spreadsheets.

1.2 Main components of computer systems

A typical computer system is made up of hardware and software. Figure 1.1 shows an example of a computer system consisting of input devices, output devices and secondary storage. These will be discussed in more detail in Chapter 2, but examples include:

- **input devices**: keyboard, mouse
- **output devices**: monitor, printer
- **secondary storage devices**: DVD R/W drive, removable hard drive.

However, one part of the computer system has not yet been mentioned. This is shown as the 'Processor and internal memory devices' in the diagram – this consists of four key components called the **central processing unit (CPU)**, internal **hard disk**, **random access memory (RAM)** and **read only memory (ROM)**.

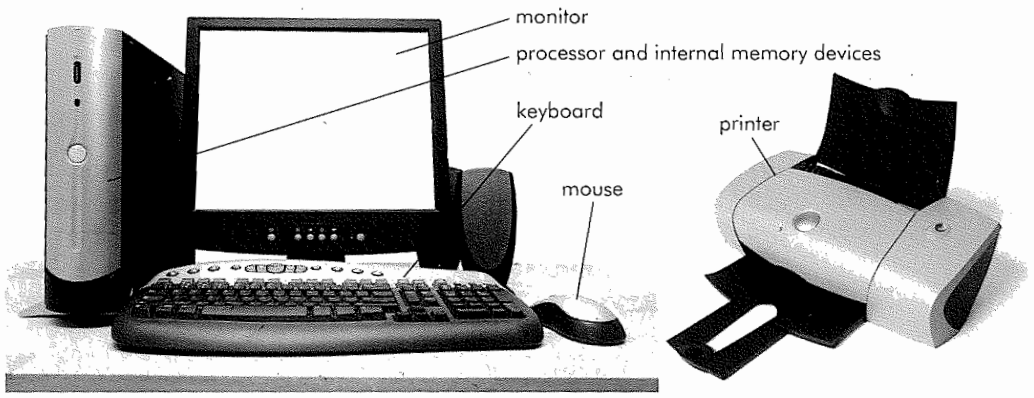


Figure 1.1 A typical computer system

The central processing unit (CPU) is the part of the computer which interprets and executes the commands from the computer hardware and software. CPUs used to be made up of discrete components and numerous small integrated circuits, which were combined together on one or more circuit board/s. However, due to modern manufacturing techniques, the term **microprocessor** is now used instead of CPU. This is a single integrated circuit (see Figure 1.2) which is at the heart of most PCs and is also found in many household devices and equipment where some control or monitoring is needed (e.g. the engine management system in a car).

The internal hard drive is the computer's main memory; this is where the **applications software**, disk **operating system** and **data files** are stored. The main advantage of these memories is the fast data transfer/access times and their large capacity to store data (this is discussed further in Chapter 3).

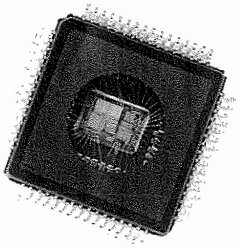


Figure 1.2 Typical microprocessor

Random access memory (RAM) is an internal chip where data is temporarily stored when running applications. This memory can be written to and read from. Since its contents are lost when power to the computer is turned off, it is often referred to as a 'volatile' or 'temporary' memory.

Read only memory (ROM) is a memory used to store information that needs to be permanent. It is often used to contain, for example, configuration data for a computer system. These chips cannot be altered and can only be read from (hence their name). One of the main advantages is that the information stored on the ROM chip is not lost even when power is turned off to the computer. They are often referred to as 'non-volatile' memories.

It is worth noting that ROM also contains some coding known as the boot file. This code tells the computer what to do when it first starts up; it is often referred to as the **BIOS (basic input/output system)**. When the computer is turned on, the BIOS carries out a hardware check to find out if all the devices are present and whether they are functional. Then it loads the operating system into the RAM. The BIOS stores the date, time and system configuration in a non-volatile chip called a **CMOS (complementary metal oxide semiconductor)**, which is usually battery powered.

1.3 Operating systems

Reference to operating systems has already been made earlier in this chapter.

To enable users to communicate with computer systems, special software, known as operating systems, have been developed. The general tasks for a typical operating system include:

- controlling the operation of the input, output and backing storage devices
- supervising the loading, running and storage of applications programs

- dealing with errors that occur in applications programs
- maintaining security of the whole computer system
- maintaining a computer log (which contains details of computer usage)
- allowing communication between user and the computer system (user interface).

Computer users need to be able to communicate with the operating system – this is called the 'user interface'. There are two main types of user interfaces: **command line interfaces (CLIs)** and **graphical user interfaces (GUIs)**.

Command line interfaces

CLIs require a user to type in instructions in order to choose options from menus, open software etc. There are often a number of commands that need to be typed in, for example, to save or load a file. The user therefore has to learn a number of commands just to carry out basic operations. It is also slow having to key in these commands every time an operation has to be carried out. However, the advantage of CLI is that the user is in direct communication with the computer and is not restricted to a number of pre-determined options.

For example, Figure 1.3 shows the CLI code required for importing data into a table called B.

```
1. SQLPrepare(hStmt,
2. ?            (SQLCHAR *) "INSERT INTO tableB SELECT * FROM
                tableA",
3. ?            SQL_NTS):
4. ? SQLExecute(hStmt);
```

Figure 1.3 Example of CLI code

The above statements show how complex it is just to carry out a fairly straightforward operation using CLI.

Graphical user interfaces

GUIs allow the user to interact with a computer (or MP3 player, gaming device, mobile phone, etc.) using pictures or symbols (**icons**) rather than having to type in a number of commands. For example, the whole of the CLI code shown in Figure 1.3 could have been replaced by a single icon:  (table update). Simply selecting this icon would automatically execute all of the steps shown in Figure 1.3 without the need to type them in each time.

GUIs use various technologies and devices to provide the user interface. One of the most common is **windows icons menu and pointing device (WIMP)** which was developed for use on **personal computers (PCs)**. This uses a mouse to control a cursor, which then selects icons to open/run windows. Each window contains an application and modern computer systems allow several windows to be open at the same time. In the example shown in Figure 1.4, a number of icons can be seen on the left-hand side and on the bottom right; three windows are open and these are shown as grey rectangles at the bottom of the screen.

A windows manager looks after the interaction between windows, the applications and the windowing system (which handles the pointing devices and the cursor's position).

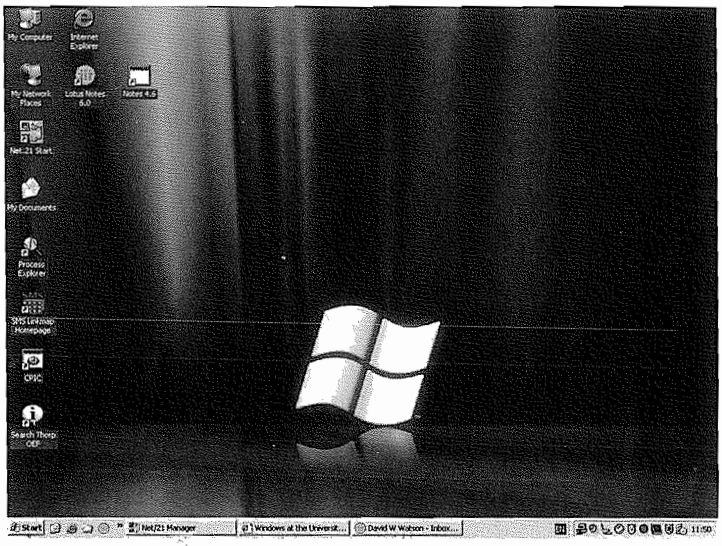


Figure 1.4 A typical GUI

In recent years, devices such as **touch screen** phones use **post-WIMP** interaction, where fingers are in contact with the screen. This allows actions such as **pinching** and rotating, which would be difficult to do using a single pointer and device such as a mouse.

1.4 Types of computers

There are many types of computer systems in existence. This section summarises some of the more common types currently available.

PC/desktop computers

PC/desktop usually refers to a general purpose computer which is made up of separate monitor, keyboard, mouse and processor unit (see Figure 1.1). The term PC (personal computer) usually refers to computer systems which are IBM-compatible, thus distinguishing them from, for example, Macintosh systems.

It is worth making a comparison here with laptop computers:

Advantages

- Spare parts and connections tend to be standardised, which usually results in low costs.
- Desktops tend to have a better specification (e.g. faster processor) for a given price (often due to size and construction constraints in laptops).
- The large casing allows good dissipation of any heat build-up.

Disadvantages

- Desktops are not particularly portable since they are made up of separate components.
- All the components need to be hooked up by wiring, which can be quite complex and clutters up the desk space.
- Because they are not particularly portable, it is necessary to copy files, etc. when you want to do some work elsewhere (e.g. at home).

Laptop computers

Laptop (or notebook) refers to a type of computer where the monitor, keyboard, pointing device and processor are all together in one single unit. This makes them extremely portable systems.

The key features you would expect to find in a laptop are:

- low weight (to aid portability)
- low power consumption (and also long battery life)
- a processor that does not generate too much heat (cooling is very important).

Advantages

- They are very portable, since the monitor, pointing device, keyboard, processor and backing store units are all together in one single box.
- There are no trailing wires, etc. because everything is in one single unit.
- They can take full advantage of **WiFi** (see discussion in Chapter 4).
- Since they are portable, they can link into any multimedia system.

Disadvantages

- Since they are portable, they are easy to steal!
- They have limited battery life so the user may need to carry a heavy adaptor.
- The keyboards and pointing devices can sometimes be awkward to use.
- Heat dissipation is more difficult due to the structure of the laptop computers.

Netbooks

Netbook is a term used to describe a computer that can almost fit onto a hand and is a smaller version of a laptop. These used to be known as **palmtop** computers, but this term now generally applies to much smaller devices which use touch screens and often a stylus to key in data (see below).

Advantages

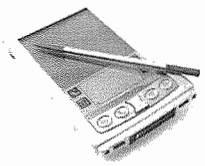
Netbook computers have many of the features of laptops and therefore have similar advantages and disadvantages.

Disadvantages

In addition to the disadvantages listed above for laptops:

- netbooks don't have optical drives
- the keyboards are only about 80 per cent the size of laptop keyboards
- they lack some of the features found in larger machines, principally due to the size constraints and to the fact that they are cheaper to purchase.

Personal digital assistants



Personal digital assistants (PDAs) are small handheld computers that usually come with a touch screen that is activated using a stylus. Data (e.g. text) is entered by using a keyboard that appears on the touch screen. Originally, these devices were used as personal organisers but their use has expanded somewhat to include new generation mobile phones, **data loggers**, satellite navigation systems, etc. Many PDAs now have basic database, **word-processing** and **spreadsheet** facilities.

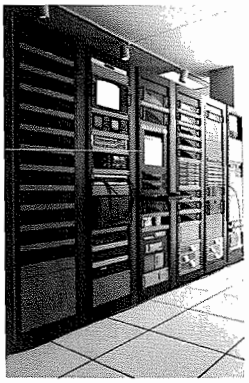
Advantages

- They can be used anywhere because of their size.
- They are very lightweight and are more portable than laptop computers.

Disadvantages

- It is difficult to enter text quickly.
- They have very limited capabilities due to the software and the operating system used.

Mainframe computers



Mainframe computer is a term used for a large, very powerful, computer system. The name comes from the days when the individual components were housed in large (often room-sized) frames.

Uses

Their main purpose is to run commercial applications, such as banking and insurance, where huge amounts of data need to be processed each day.

The main features of main frame computers are as follows.

- They can have several CPUs.
- They have very fast processor speeds.
- They can support multiple operating systems.
- They have huge amounts of storage capacity.
- They have huge internal memories (e.g. several hundred Gbyte of RAM).
- They often operate using time sharing or batch processing (see Chapter 7).

Advantages

- Due to the features listed above, they can be used to do very large jobs which require large memories and very fast processor time.
- They are used in time-sharing systems to allow users to be given a time slice of the very powerful facilities afforded by a mainframe system.
- They are capable of very large number crunching, and so can deal with very complex mathematical functions (e.g. fractals) which would be very time consuming using, for example, a PC.

Disadvantages

- Mainframe computers need to be permanently housed in a large room, so cannot be moved around.
- They are very expensive to operate and maintain.

CHAPTER 2

Input and output devices

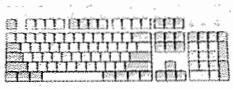
In this chapter you will learn about:

- input devices:
  - the uses of each device
  - the advantages of each device
  - the disadvantages of each device
- output devices:
  - the uses of each device
  - the advantages of each device
  - the disadvantages of each device
- control applications and the uses of each device.

2.1 Input devices

As the name suggests, input devices are hardware devices that allow data to be input into a computer. Many such devices exist, ranging from the more common ones, such as the keyboard, through to the more specialist devices, such as barcode readers. A number are described in this section.

Keyboards



These are the most common input devices and are used to input text, numbers and instructions into the computer. Most use the **QWERTY** layout (this name comes from the keys on the top row, which spell out 'QWERTY').

Ergonomic keyboards have also been developed recently. These are designed to reduce health-related problems associated with the standard keyboard (e.g. carpal tunnel syndrome or repetitive strain injury (RSI) – see Section 6.7).

Uses

- Keyboards are used to input data into applications software (e.g. text into word processors, numbers into spreadsheets, etc.).
- They are also used for typing in commands to the computer (e.g. Prnt Scrn, Ctrl+P to print out, etc.)

Advantages

- Keyboards enable fast entry of new text into a document.
- They are a well-tried technology and a well-known method of entry.
- Most people find them easy to use.
- It is easy to do **verification** checks as data is entered, as it appears on the screen simultaneously.

Disadvantages

- Users with limited arm/wrist use can find keyboards hard to use.
- Entering data using a keyboard is slow when compared to direct data entry (e.g. **optical mark recognition**).
- Keyboards are fairly large devices that use up valuable desk space.

The **concept keyboard** uses icons or phrases instead of standard letters. These are often used in, for example, fast food restaurants, offices and shops, where a single key represents an item. For example, the symbol shown in the photo represents 'add tax'. The person using the keyboard only needs to touch this key to calculate the tax on an invoice.

Advantages

- Concept keyboards enable fast data entry, as there is no need to type in whole commands.
- They are waterproof, which is useful in a restaurant environment.
- These keyboards are tamper proof and so are useful in certain applications (e.g. at unmanned airport information kiosks), preventing people from keying in information which could potentially corrupt the computer system.

Numeric keypads

A **numeric keypad** is used to enter numbers only (although some have a function key to allow input of alphabetic characters).

Uses

- Numeric keypads are used in **automatic teller machines** (ATMs), where customers can key in their **personal identification number** (PIN), an amount of money, etc.
- Telephones have numeric keypads to allow phone numbers, etc. to be keyed in.
- **Electronic point of sale** (EPOS) **terminals** have numeric keypads in case the barcode reader fails to read the barcode and the number has to be keyed in manually by the operator.
- Chip and PIN devices have numeric keypads for entry of PIN, amount of money, etc.
- They are used to enable fast entry of numeric data into a spreadsheet.

Advantages

- Numeric keypads are faster than standard keyboards for entry of numeric data.
- Since many are small devices (e.g. mobile phones), they are very easy to carry around.

Disadvantages

- They can be difficult to use, due to very small keys.
- It is difficult to use them for entering text.
- Sometimes the order of the numbers on the keypad isn't intuitive.

Mice

The **mouse** is an example of a **pointing device**. A ball is used underneath the mouse to detect movement, so by moving the mouse around the user can control the position of a pointer on the screen. There are usually two buttons, which have different functions: very often the left button is used to select something by double clicking it and the right button brings up drop-down menus (see Figure 2.1).

Many mice also have a scroll button, which speeds up the process of moving through a document.

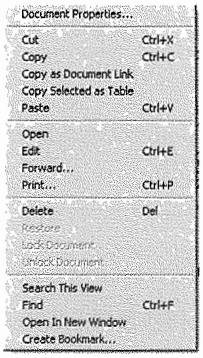


Figure 2.1 Example of a drop-down menu

Recent developments have produced the **optical mouse** (where movement is detected by reflected light rather than the position of a moving ball) and the **cordless mouse** (which is an example of a wireless device). The advantage of an optical mouse is it has no moving parts and it also doesn't pick up any dirt. This makes it more robust and improves its performance, since the older type of mouse can 'skid' on certain surfaces reducing the control of the pointer.

Uses

- Mice can be used for opening, closing and minimising software.
- They can be used for grouping, moving and deleting files.
- They are very useful when editing images, for example controlling the size and position of a drawing pasted into a document.
- Mice are used for controlling the position of a pointer on the screen to allow selection from a menu or selecting an icon and for scrolling up and down/left to right.

Advantages

- It can be faster to select an option using a mouse rather than a keyboard.
- Mice enable rapid navigation through applications and the internet.
- Mice are small and so take up little area.

Disadvantages

- People with restricted hand/wrist movement can find it hard to operate a mouse.
- Mice are easily damaged and the older type of mouse also quickly becomes clogged up with dirt.
- They are difficult to use if there is no flat surface readily available (e.g. on an aeroplane).

Touchpads

Touchpads are used in many laptop computers as a pointing device. The pointer is controlled by the user moving their finger on the touchpad and then gently tapping it to simulate the left hand button of a mouse (i.e. selection). They also have buttons under the touchpad which serve the same function as the left and right buttons on a mouse.

Uses

The uses of a touchpad are the same as those of a mouse.

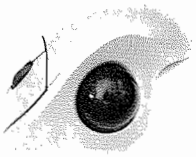
Advantages

- It can be faster to select an option using a touchpad rather than a keyboard.
- Touchpads enable rapid navigation through applications and the internet.
- Since the touchpad is integrated into the laptop computer, there is no need for a separate mouse, aiding portability.
- They can be used even when there are no flat surfaces available.

Disadvantages

- People with limited hand/wrist movement find touchpads difficult to use.
- It can be more difficult to control the pointer when compared with a mouse.
- They are more difficult to use when doing certain operations such as 'drag and drop'.

Trackerballs



Trackerballs are similar to a mouse, except that the ball is on the top of the device and the user controls the pointer on the screen by rotating the ball with the hand. Some trackerballs have two buttons which have the same function as the left- and right-hand mouse buttons. If they have a third button, this is equivalent to a double click.

Uses

- They have the same pointing/cursor control capability as a mouse.
- They are used in applications where the user has a disability (such as RSI).
- They are used in a control room environment, where it is faster than a mouse to navigate through process screens and is more robust than a mouse.

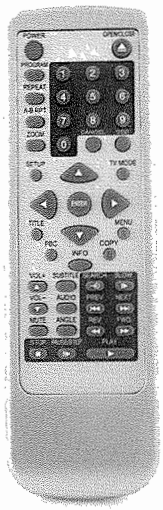
Advantages

- Trackerballs do not need the same fine control as a mouse.
- People with limited hand/wrist movement find it easier to use than a mouse.
- The pointer can be positioned more accurately on the screen than with a mouse.
- They take up less desk space than mice since they are stationary.

Disadvantages

- Trackerballs are not supplied with the computer as standard, so they are more expensive.
- User may need training since they are not standard equipment.

Remote controls



A **remote control** is used to control the operation of other devices remotely by using infra red signals. The buttons on the keypad are used to select options (such as television stations, sound levels on a hifi, timings on a DVD recorder, etc.).

Uses

- Most home entertainment devices such as a television, satellite system, DVD player/recorder, hifi systems, etc. have remote controls.
- Remote controls are also used to control multimedia systems.
- They are used in industrial applications to remotely control processes, stop and start machinery, etc.

Advantages

- Remote controls enable devices to be operated from any distance, which is particularly useful for people with disabilities.
- Some chemical processes are hazardous, so it is safer to operate equipment from a distance.

Disadvantages

- People with limited hand/wrist movement can find them hard to use.
- The signal between the control and the device can be easily blocked.

Joysticks

Joysticks have similar functions to mice and trackerballs. By gripping the stick, a pointer on the screen can be controlled and buttons are used to make selections. Often they have another button on the top of the stick that is used for gaming purposes, e.g. to fire a weapon.

Uses

- Video/computer games are often controlled by joysticks.
- They are used in **simulators** (e.g. flight simulators) to mimic actual controls.

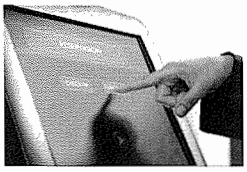
Advantages

- It is easier to navigate round a screen using a joystick rather than a keyboard.
- Control is in three dimensions.

Disadvantages

- It is more difficult to control the on-screen pointer with a joystick than with other devices, such as a mouse.

Touch screens



With this system the user can choose an option by simply touching the button/icon on the screen. The selection is automatically made without the need for any pointing device.

Uses

- Touch screens are used for self-service tills, e.g. petrol stations, where the user just touches the screen to select the fuel grade and payment method.
- Touch screens are used where selections are made on screen, for example ATMs, point of sale terminals (e.g. at restaurants), public information systems at airports, railway stations, tourist offices.
- Personal digital assistants (PDAs), mobile phones and satellite navigation systems use touch screens.
- Interactive white boards used for education are large touch screens.
- Touch screens are used in computer base training (CBT) where selections are made in answering on screen testing.

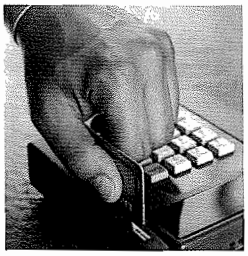
Advantages

- Touch screens enable faster entry of options than using a keyboard or a mouse.
- It is very easy to choose options.
- It is a user friendly method for inputting data, so no training is necessary.
- Touch screens are tamper proof, preventing people from keying in information which could potentially corrupt the computer system (e.g. at unmanned ticket collection kiosks).

Disadvantages

- There is a limited number of options available.
- Using touch screens frequently can lead to health problems (e.g. straining of arm muscles, RSI, etc.).
- The screen can get very dirty with constant touching.

Magnetic stripe readers



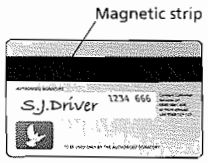


Figure 2.2 The magnetic stripe on a credit card

These are used to read information on the **magnetic stripe** found, for example, on the back of a credit card (see Figure 2.2). The stripe contains useful information, such as the account number, sort code, expiry date and start date.

Uses

- Credit and debit cards have magnetic stripes that are used by ATMs or EFTPOS (electronic funds transfer point of sale) terminals.
- Security cards for entry to buildings, hotel rooms, etc. use magnetic stripes.
- Travel systems (e.g. train and underground tickets) use magnetic stripes.

Advantages

- Data entry is faster compared with keying in using a keyboard or keypad.
- The system is error free, since no typing is involved.
- The information held on the magnetic stripe is secure: because it cannot be read directly by a person; and, since there is no typing, there is not the risk of somebody observing your key strokes.
- They can prevent access to restricted/secure areas.
- Magnetic stripes are unaffected by oil, water, moisture, etc.
- There are no moving parts, so they are physically very robust.

Disadvantages

- If the magnetic stripe gets damaged (e.g. due to exposure to a strong magnetic field or excessive use) the data is lost.
- The card needs to be in close contact with the reader, so magnetic stripe readers don't work at a distance.
- Since the information is not human readable, this can be a disadvantage in some applications (e.g. hotel room numbers are not printed on the card, so there needs to be another way of showing the information for the customer).

Smart card readers

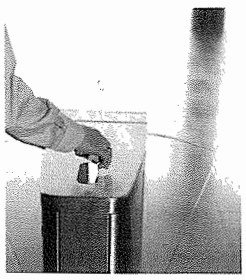


Figure 2.3 The chip on a smart card

Smart cards contain chips (see Figure 2.3) and are similar to magnetic stripe cards. With these cards the information is stored on the chip (e.g. PIN and personal data). The data stored on the chip can be updated (e.g. on loyalty cards). For example, certain oil companies use these cards: when a customer buys fuel at a filling station, the loyalty card is swiped and 'points' are added to the card; these points can be used for air miles, money off next purchases, and so on. The storage capacity of the chip is much greater than a magnetic stripe, so more information (such as customer details) can be stored.

Uses

- Loyalty cards, ID cards and public transport passes use smart cards.
- Smart cards can be used to track customer/passenger movements (e.g. on a metro system).
- They are used with satellite systems to decode program signals.
- Smart cards are used for electronic passports and driving licences.

Advantages

- Some smart cards (e.g. transport tickets) are used instead of money, reducing the need to carry cash.
- The chip on the card does not need to be in contact with reader, so there is less damage compared with a magnetic stripe reader.
- Data is more secure, since it is easier to copy information on a magnetic stripe than it is to copy information on a chip.

Disadvantages

If the card is lost, information stored on the chip could be used in identity theft.

Chip and PIN readers

Chip and PIN readers are similar to smart card readers, but are used at EFTPOS terminals. The device has a slot into which the card is placed and the chip is read. The PIN is entered using the keypad. A small screen is also part of the reader, which gives instructions to the operator.

Uses

- Chip and PIN readers are used where payments are made using cards (restaurants, supermarkets, travel agents, etc.).

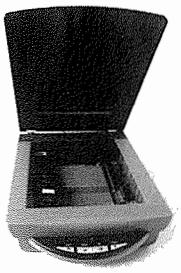
Advantages

- Chip and PIN readers provide a more secure payment system than requiring a signature or using a magnetic stripe, since the PIN typed in must match up with PIN stored on chip.
- Chip and PIN readers provide a more robust system than magnetic stripe readers, since the chip does not need to be in contact with the reader.

Disadvantages

- Since the customer types in the PIN, they need to be careful that it isn't read by somebody else, thus giving an opportunity for fraud.

Scanners



Scanners are used to enter information on hard copy (e.g. text documents, photographs) into a computer. The most common type is the flat bed (as shown here) which is made up of a glass panel and lid. The hard copy document or photo is scanned by a light source and produces a computer-readable image.

The subsequent image can then be manipulated using a drawing package. Images can also be used with optical character recognition (OCR) software to allow the information to used in a word processor, desktop publishing, presentation software, etc. Specialist scanners exist which are designed to carry out a specific task, e.g. barcode scanners (discussed later in this section).

Uses

- Scanners are used to scan in documents and convert them into a format for use in various software packages.
- Old and valuable documents and books can be scanned, thus protecting the originals from damage through handling and also producing records in case the paper copies are lost or destroyed.
- Non-digital photographs need to be scanned if they are to be stored on computer.

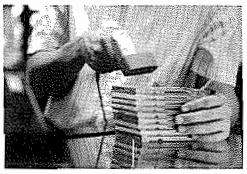
Advantages

- Images can be stored for editing at a later date (paper documents cannot be edited unless they are scanned first).
- Scanners are much faster and more accurate (i.e. no typing errors) than typing in documents again.
- It is possible to recover damaged documents and photographs by scanning them and then using appropriate software to produce an acceptable copy.

Disadvantages

- The quality can be limited, depending on how good the scanner resolution is.

Barcode readers



Barcode readers are used to read information in the form of a bar code (illustrated in Figure 2.4). The readers are usually in the form of a barcode scanner and are often built into POS terminals in supermarkets. *Handheld scanners or wands* (as shown here) are also very common for reading barcodes if portability is required (e.g. if the barcodes are on large or fixed objects).

Figure 2.4 A barcode

Uses

- Barcode scanners are used in supermarkets and other shops where the goods are marked with a barcode; the barcodes are used to give information about the product, which enables automatic stock control, itemised billing, etc. to take place.
- They are used in libraries, to scan both users' library cards and barcodes on books, in order to keep track of books on loan.
- They are used as a safety function in many companies to ensure that electrical equipment is checked on a regular basis. Barcodes are placed on an item to identify it and a database holds all the information related to that barcode so it is possible to interrogate the system as part of a safety audit.

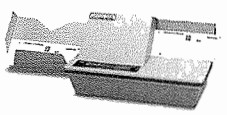
Advantages

- Scanning barcodes is much faster than keying in data manually and fewer mistakes are made.
- When barcodes are used as a way of recording data, they can improve safety.
- Barcodes enable automatic stock control.
- Barcode scanning is a tried and trusted technology.
- When an item price is changed, only the central database needs to be updated. There is no need to change the prices individually on each item.

Disadvantages

- Barcode scanning is a relatively expensive system to administer since every item in the shop needs a barcode and every barcode needs to be entered on to the central database. Also, there is a need to invest in the computer technology together with staff training, which can all be very expensive.
- The system is not foolproof – barcodes can be swapped around on items!

OMR devices



Optical mark recognition (OMR) is a system which can read marks written in pen or pencil. The places where the pen or pencil marks can be made are clearly shown on the form, for example:

1 ●–● 2 ● ● 3 ● ●

In this example, a pencil mark has been made between the dots on answer 1. The position of the mark is stored in the computer's memory after being read by the OMR device.

Uses

- OMR devices are used to read questionnaires, multiple-choice examination papers and many other types of form where responses are registered in the form of lines or shaded areas.

Advantages

- It is a very fast way of inputting the results of a survey, etc. – the documents are fed in automatically and there is no user input.
- Since there is no typing, it is more accurate than keying in the data.
- OMR is more accurate than OCR (discussed later in this section).

Disadvantages

- The forms need to be carefully designed to make sure that the marks/shading are correctly positioned to gather accurate information.
- There can be problems if the forms haven't been filled in correctly and sometimes they have to be manually checked before being read by the OMR device – this is both time consuming and expensive.

OCR readers

Optical character recognition (OCR) is the name given to software that takes scanned text and converts it into a computer readable form. The text can then be used in various application packages such as word processors, desktop publishers and presentation software.

Uses

- One of the most recent uses is in the processing of passports and identity cards.
- OCR is used when scanning in documents so that they can be modified using a word processor or desktop publisher package.

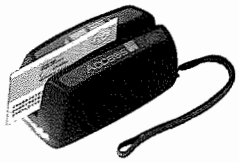
Advantages

- It is a much faster data entry system than manually keying in data.
- Since no manual data entry, the number of errors is also reduced.

Disadvantages

- The system still has difficulty reading handwriting.
- It is still not a very accurate technique.

MICR devices



Magnetic ink character recognition (MICR) is a system which can read characters printed in a special ink (containing iron particles). Only certain characters written in a standard font can be read, for example the characters at the bottom of a bank cheque (see Figure 2.5). These characters are converted into a form that the computer can understand and then stored in a computer file.

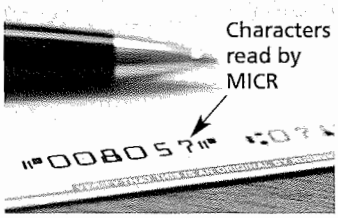


Figure 2.5 A bank cheque

Uses

- It is primarily used to process cheques in banking operations. When a cheque is presented its value is then printed on the cheque in the special ink. The cheques are all gathered together (either at the end of the day or after some specified period) and then read using a **batch processing** method (see Section 7.9).

Advantages

- MICR offers greater security than OCR since the printed characters cannot be altered.
- There is no manual input, thus errors are reduced.
- Even if somebody writes over the magnetic ink characters (e.g. with a signature) they can still be read.

Disadvantages

- Only certain characters can be read and the number of different characters is very limited.
- It is a more expensive method than other methods used in direct data entry.

Digital cameras

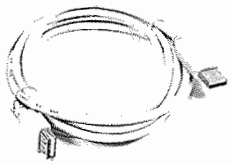


Figure 2.6 USB connectors

Digital cameras are rapidly replacing traditional, film-based cameras. Once photographs are stored in memory, they are easily transferred to a computer using a **universal serial bus (USB)** connection (see Figure 2.6). Once saved, the images can be manipulated (e.g. cropped, re-sized, contrast altered, etc.).

Uses

- Digital cameras produce photographs for transfer to a computer directly or to print out by connecting directly to a printer.
- Many digital cameras also allow short video clips to be produced.
- Photographs can be uploaded directly into applications software such as word processors, desktop publishers, etc.

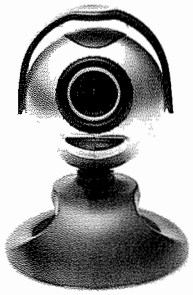
Advantages

- It is easier to produce better quality photographs than with a traditional camera.
- It is easier and faster to upload photographs to a computer rather than having to scan in hard copies when using traditional methods.
- There is no need to develop film and print out photographs any more – this saves money and is also environmentally more acceptable (saves paper and no longer need the chemicals used in developing the films).
- It is easy just to delete an image from memory if it is not satisfactory and take the photograph again.
- The memory cards can store several hundred photographs. A traditional camera was limited by the number of photographs that could be taken on a roll of film.

Disadvantages

- The camera user needs to be computer literate to use the cameras properly; also the transferring, storing and manipulating of the images via a computer requires some understanding of how computers work.
- There is some artistry lost since clever software now corrects errors in the photographs (e.g. incorrect exposure, removal of red eye, etc.).
- The resolution is not yet as good as traditional cameras, although this is improving all the time. The quality of photographs depends on the number of **pixels** (many cameras now offer more than 10 mega pixels per image), quality of lens, etc.
- Images often need to be compressed to reduce the amount of memory used (a single image can use more than 2 Mbytes of memory, for example).
- It is possible to fill up computer memory very quickly with several photographs of the same subject in an attempt to find the 'perfect' snap shot.

Webcams



Webcams are similar to digital video cameras; however, they are connected directly to the computer (through a USB port) and they do not have a memory. The information that the webcam picks up is transmitted directly to the computer. Many computer systems now have webcams built into the top of their monitors as standard equipment.

Uses

- While chatting online, many people use webcams as a more personal way of having a conversation.
- They are used to enable video conferencing to take place (discussed in Chapter 4).

Advantages

- Webcams can be left on constantly, only being activated as required.
- They allow people to keep in contact with each other without the need to travel, so they are particularly useful for elderly or disabled people.

Disadvantages

- Webcams have very limited features and the picture is often of poor quality.
- They need to be connected to the computer, although this is less of an issue with laptop computers when the webcam is built into the monitor lid.

Microphones

Microphones can be connected directly to a computer. Sounds can be inputted and then manipulated. The input sound is converted to an analogue signal and then converted into a digital signal. The computer's sound card usually does this automatically (i.e. it acts as an **analogue to digital converter (ADC)**.

Uses

- Microphones are used to input speech/sounds to be used in various applications, e.g. presentations, sampling (in films, music, etc.), special effects (films).
- They are used in voice recognition software, which can have a number of purposes, for example:
  - conversion of speech into text that can be used in, for example, a word processor
  - recognition of commands (e.g. some cars now have voice-activated systems to switch on the lights, turn up the radio volume, etc.).

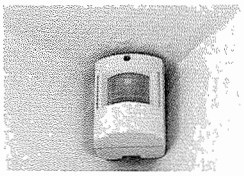
Advantages

- It is faster to read in text than to type it in using a keyboard.
- Using special software, it is possible to manipulate sound in real time rather than working on a recording done at some earlier stage.
- If used in a voice activation system, this has the advantage of improving safety since, for example, car drivers don't need to take their hands off the wheel to operate a switch or alter the radio station etc.

Disadvantages

- Sound files can use up a lot of computer memory.
- Voice recognition software isn't as accurate as typing in manually (for example, the software can't distinguish the difference between 'their' and 'there').

Sensors



This section deals with **analogue sensors**. A sensor is a device which inputs data to a computer, where the data is a measurement of some physical quantity which is continuously changing (e.g. temperature, light, moisture, etc.). These physical quantities are analogue in nature. Since computers only understand digital data (i.e. 1s and 0s), the information from the sensors needs to be converted into a digital form. This is done using an analogue to digital converter (ADC).

Uses

Sensors are used in monitoring and control applications – the type of sensor depends on the application (see Table 2.1). When monitoring, the data sent to the computer is often transferred directly to a spreadsheet package (e.g. taking measurements in a scientific experiment, measuring atmospheric pollution, etc.).

Type of sensor	Applications
Temperature	Automatic washing machines, central heating systems, automatic greenhouses, ovens
Pressure	Burglar alarm systems, washing machines, robotics, environmental monitoring
Light	Automatic greenhouses, automatic doors, burglar alarm systems, street lighting control
Sound	Burglar alarm systems, monitoring liquid and powder flow in pipes
Humidity/moisture	Automatic greenhouses, environmental monitoring, factories where moisture levels are crucial (e.g. manufacture of microchips, paint spraying)
pH	Automatic greenhouses, chemical processes, environmental monitoring

Table 2.1 Applications of different types of sensors

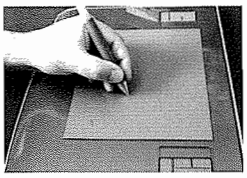
Advantages

- Readings taken using sensors are generally more accurate that those taken by human operators.
- Readings are continuous, so there is no break in the monitoring.
- Because it is a continuous process, any necessary action (control system) or warning (monitoring system) will be initiated immediately.
- The system can be automatic, removing the need for human intervention. This is particularly important if the process is hazardous or needs precise control/monitoring.

Disadvantages

- Faulty sensors can give spurious results (e.g. if the sensors on the rear bumper of a car which monitor for obstacles become dirty, they may either not identify an obstacle or give a continuous alarm).

Graphics tablets



A **graphics tablet** is used with a stylus to produce freehand drawings for example. The images produced can then be stored in a file on a computer.

Uses

- Graphics tablets are used to produce drawings, computer graphics, etc.
- In countries where characters are complex (e.g. China, Japan), they are used as a form of input since it is faster than typing in the characters using a keyboard.
- They are used in **computer aided design (CAD)** work.

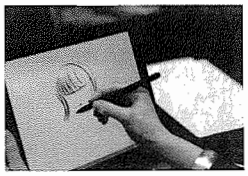
Advantages

- It is possible to modify drawings before they are input.
- They offer a very accurate method of drawing, which is better than using a mouse or trackerball.

Disadvantages

- They are more expensive than other pointing devices, such as a mouse.

Light pens



Light pens contain sensors that send signals to a computer whenever light changes are detected. At the moment, the devices only work with **cathode ray tube (CRT) monitors** (see Section 2.1) because they rely on the screen image being built up row by row by an electron beam. The screen is refreshed 50 times every second, so the computer is able to determine the pen's position by noting exactly when the light pen detected the electron beam passing its tip. Systems to operate with **thin film transistor (TFT) monitors** are still at the development stage.

Uses

- Light pens are used for selecting objects on CRT screens.
- They are also used for drawing on screen (e.g. with CAD packages).

Advantages

- Light pens are more accurate than touch screens.
- They are small, so can be used where space is an issue.
- They are easy to use.

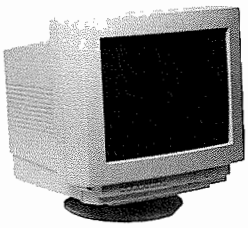
Disadvantages

- There are problems with lag when drawing on screen.
- At the moment, they only work with CRT monitors.
- They are not very accurate when drawing.

2.2 Output devices

As the name suggests, output devices are hardware devices that allow data to be output from a computer. Some devices hold the data temporarily (such as a printer) whereas other devices produce permanent output in the form of a hard copy (such as a printer producing output on paper). There is a third type of output device which is used to control processes in conjunction with sensor input devices. These are covered separately in Section 1.3.

CRT monitors



CRT monitors are the least expensive type of monitor, although they are becoming increasingly rare as TFT monitors are now taking over. They come in various sizes. They use an electron gun to fire against a phosphor screen, which creates a picture that is made up of tiny dots. Each dot is coloured red, green or blue – the intensity of each coloured dot makes up the vast range of colours interpreted by the eye.

Uses

- CRT monitors are used as the primary output device for computers so the user can see immediately what they are typing in.
- They are used with light pens, for example to allow designs to be created on screen.

Advantages

- CRT monitors still produce a higher quality image than TFT monitors.
- The angle of viewing is still better than with a TFT monitor.
- They work with light pens in computer-aided design and computer-aided manufacturing (CAD/CAM) applications.

Disadvantages

- CRT monitors tend to be rather heavy and are a weight hazard if not supported properly.
- They run very hot and can cause fires if left unattended (especially as they get older).
- They consume considerably more power than the modern TFT monitors.
- They can flicker, which can lead to headaches and eyesight problems with prolonged use.

TFT monitors

TFT monitors are taking over from CRT monitors as the main output device. One of the reasons for the rapid development of laptop computers can be attributed to the advancements made in TFT technology. The screen is made up of thousands of tiny pixels, which are made up of transistors controlled by a microprocessor. Each pixel has three transistors, coloured red, green or blue; the intensity of each governs the effective colour of the pixel seen by the eye.

Uses

- TFT monitors are used as the primary output device for computers so the user can see immediately what they are typing in.
- They are an integral part of laptop computers.

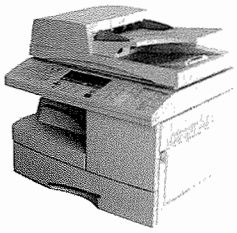
Advantages

- TFT monitors are lightweight, so do not pose the same risks as CRT monitors.
- They produce less glare than CRT monitors and also emit less radiation.
- They consume much less power and do not generate as much heat as a CRT monitor.

Disadvantages

- The angle of viewing a TFT monitor is fairly critical, with the image appearing unclear when viewed slightly from the side. This can be an issue if several people are looking at a screen at the same time.
- The definition is sometimes not as good as CRT monitors.
- TFT monitors cannot yet be used with light pens, so these monitors cannot be used in CAD if light pens are used to create and edit drawings.

Laser printers



Laser printers produce very high-quality hard copy output. The print rate per page is very quick if a large number of pages are being printed. They rely on large buffer memories, where the data for the whole document is stored before the pages can be printed out.

Uses

- Laser printers are used where noise levels need to be kept low (e.g. in an office).
- They are the best option for fast high quality high volume printing.

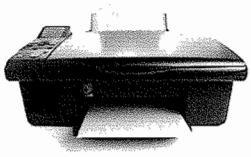
Advantages

- Printing is fast for high volumes. If only a few pages are to be printed they are little faster than inkjet printers.
- They can handle very large print jobs.
- The quality is consistently high.
- Toner cartridges last for a long time, so laser printers can be a cost effective option, particularly if colour outputs are not required.

Disadvantages

- Laser printers are expensive to buy.
- They are only really fast if several copies are being made.
- Colour laser printers tend to be expensive to run, since four cartridges (three colours plus black) are needed as well as diffuser kits, etc.
- They produce ozone and volatile organic compounds because of their method of printing and type of toner/ink used. These have been linked to health hazards in the office.

Inkjet printers



Inkjet printers are used to produce good quality hard copies. Although the quality is not quite as good as that from laser printers, it is far better than that from dot matrix printers. Unlike laser printers, inkjet printers do not have large buffers, so printing is done a bit at a time. This is why printing is sometimes paused, since the whole page can't be stored in the buffer and it has to wait for the computer to send more data.

Uses

- Inkjet printers are used where low output volumes are required.
- If high-quality printing is required for single pages (or only a small print job) then these printers are ideal, for example they are very good at producing photo quality printouts.
- 3D inkjet printers are now being used in industry to produce prototypes (see below).

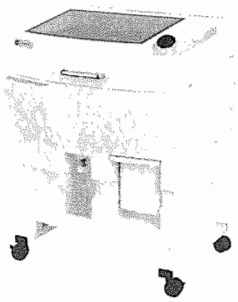
Advantages

- The output is of high quality.
- Inkjet printers are cheaper to buy than laser printers.
- They are very lightweight and have a small footprint (i.e. take up little space).
- They do not produce ozone and volatile organic compounds, unlike laser printers.

Disadvantages

- The output is slow if several copies needed, as there is little buffer capacity to store the pages.
- The ink cartridges run out too quickly to be used for large print jobs.
- Printing can 'smudge' if the user is not careful.
- Inkjet printers can be expensive to run if they are used a lot, since original ink cartridges are expensive.

3D inkjet printers



These are a new type of printer that produce solid 3D models using modified inkjet technology. In this technology, known as 'tomography', thin layers of fine powder (plaster, resin and starch) are bonded together as a 3D model is slowly built up (each layer is only about 0.25 mm thick). Figure 2.7 shows some items produced on a **3D inkjet printer** – these are known as prototypes.

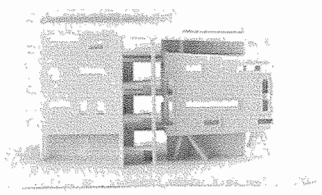


Figure 2.7 A prototype produced on a 3D inkjet printer

Uses

- Inkjet printers are used to produce prototypes which actually work from CAD packages, photograph images, stored drawings, etc.
- Scale models are produced in colour before the real thing is manufactured.
- The ultimate objective is to produce organic objects (such as replacement human organs) using this layering technology.

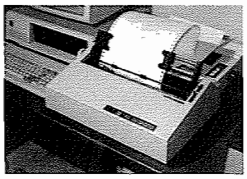
Advantages

- 3D inkjet printers save a lot of money, since making prototypes by other methods is very time consuming and expensive.
- Physical scale models are produced with working parts, which gives a better idea of how the end product will look.
- The powders used can often be ground up and re-used.

Disadvantages

- 3D inkjet printers are expensive to buy.
- They are slow at producing their output.
- The end product can sometimes be a little rough and often needs further work to be done on it.

Dot matrix printers



Dot matrix printers are a type of impact printer, where a printhead (made up of a matrix of pins) presses against an inked ribbon. They tend to be slow, noisy and the output is not good quality. They are still useful, however, where multi-part or continuous stationery (e.g. long reams of perforated paper) is being used.

Uses

- They can be used in noisy environments (e.g. garage workshops) and in applications where print quality is not very important.

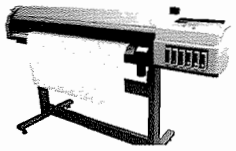
Advantages

- Dot matrix printers can be used in environments which would be a problem for laser or inkjet printers (e.g. dusty, dirty or moist atmospheres).
- Carbon copies or multi-part outputs can be produced.
- They are very cheap to run and maintain.
- They are easy to use if continuous stationery is required (e.g. long print jobs such as wages slips).

Disadvantages

- They are very noisy and so not good in an office environment.
- They cost more than an inkjet printer to buy.
- They are very slow and the printing is of poor quality.

Plotters



Plotters (also known as graph plotters) are devices that produce hard copies, but operate in a different way to printers. They are not limited to normal printer paper size and are capable of producing highly accurate, very large drawings and posters. The most common types are pen plotters (which use coloured pens to draw), electrostatic (similar method to laser printers) and inkjet plotters. With pen plotters the coloured pens are controlled by a computer and the paper can move backwards and forwards to allow accurate shapes to be drawn.

Uses

- Plotters are used to produce large drawings (e.g. blueprints of buildings, factories, etc.) and are often used with CAD applications.
- They are used to produce large pictures for use on billboards or giant posters. They can also print on plastic-coated paper.
- If the pens are replaced with cutting tools, it is also possible to make large signs.

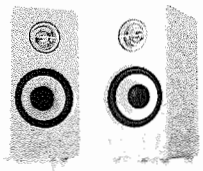
Advantages

- They can produce huge printouts.
- The print quality is extremely high.

Disadvantages

- They are slow in operation.
- They are expensive, both to buy and to maintain.

Speakers

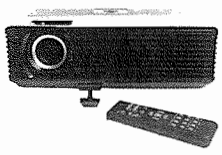


Speakers can be connected directly to a computer or are built into the monitor or casing (as in a laptop computer). Digital data from the computer is converted into analogue form, using a digital to analogue converter (DAC). The signal is then amplified through the speakers.

Uses

- Speakers are used to output sound from multimedia presentations.
- They are used in home entertainment centres.
- They can help blind people (together with speech generation software) through audio output of text on the screen.
- They are used to play downloaded sound files.

Multimedia projectors



Multimedia projectors receive signals that can be either analogue or digital, although most modern projectors only work with digital inputs. The signal source is usually from a computer, television or DVD player. The image from the source is magnified and projected onto a large screen. The devices usually work with a remote control, but can also use virtual mouse technology which actually becomes a cordless PC mouse with the same features as a mouse. It is then possible to direct the computer presentation without being tied to the computer. Another feature of the virtual mouse is the laser pointer. Most multimedia projectors take input from various types of video format such as NTSC, PAL or SECAM.

Uses

- Multimedia projectors are used for training presentations (to allow the whole audience to see the images from a computer).
- They are also used for advertising presentations (large images showing product features of, for example, a new car, can be shown at exhibitions, shopping malls, etc.).
- Home cinema systems (projecting the images from a DVD or television) use multimedia projectors.

Advantages

- They enable many people to see a presentation rather than all of them crowding round a small computer screen.
- They avoid the need for several networked computers. For example, when looking at a video clip on an internet site, everybody can see the video on the large screen rather than logging on to a number of computers.

Disadvantages

- Images can sometimes be fuzzy.
- Multimedia projectors are expensive to buy.
- Setting up projectors can be a little difficult.

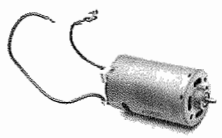
2.3 Control devices

Control devices are another type of output device. They are used to control processes in conjunction with sensor input devices. This section gives an overview of actuators and the devices that they operate, but the use of sensors and actuators are covered in more depth in Section 7.7.

Actuators

Actuators are **transducers** and are used to take signals from a computer and convert them into some form of motion, for example operating motors, pumps, switches and valves. As part of the control process, digital signals are sent from the computer to an actuator to operate a device. Usually, conversion of the digital signal to analogue is required first (using a DAC).

Motors

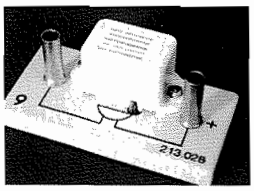


The motor is turned on or off by the actuator.

Uses

- Motors are used in many domestic appliances, such as automatic washing machines (to make the drum rotate), cookers (to switch on fans), water pumps in central heating systems and automatic greenhouses to open windows and switch on fans.
- In industry, they are used to control robot arms.
- In computers, they operate fans, disk drives and DVD drives.

Buzzers

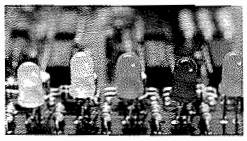


The buzzers are switched on or off by the actuator.

Uses

- Buzzers are used in cookers and microwave ovens to tell the operator when the cooking process is complete.
- They are used in burglar alarm systems to warn if intruders are present.

Lights

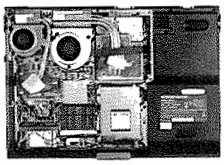


The actuator is connected to the switch that turns the lights on or off.

Uses

- They are used for security lights.
- Lights are used in greenhouses to control the lighting conditions.

Heaters



Actuators are connected to switches which turn the heater on or off.

Uses

- Heaters are used in automatic washing machines, cookers and central heating systems.
- Heaters are used in automatic greenhouses to control the temperature.

CHAPTER 3

Storage devices and media

In this chapter you will learn about:

- back-up storage
- why it is necessary to back up data and files
- the types of access used by the backing stores
- the types of internal and external backing storage devices:
  - magnetic
  - optical
  - solid state.

3.1 Backing up data

The first two sections in this chapter consider the need for backing up data and the different ways of storing and accessing data. Section 3.3 then discusses many forms of **backing storage** and compares the advantages and disadvantages of each type. The comparative performance and main uses for each type of store are also discussed in some depth.

What is backing up of data?

Backing up refers to the copying of files and data to a different medium (disk, tape, flash drive, etc.) in case of a problem with the main storage device. Backing up files and data on a regular basis is seen as good computing practice and many computer systems can be set to back up files automatically on a regular basis.

The backups are often stored in a different place to the main storage. This is in case of fire or some other situation which could lead to irretrievable loss of key data and files.

Why back up data?

There are various reasons why backups are made. Some of the more common reasons are considered below:

- Data could be lost due to failure of the original storage device. This could be due to hardware failure (e.g. head crash on a hard drive unit), problems caused by files being over-written accidentally (or otherwise) or possible corruption of files (e.g. caused by power surges).
- Hackers could be responsible for the corruption or even loss of data. This may not be their intention (they may only want to gain access to the information for other purposes, e.g. to find personal information such as bank account details). However, the very act of hacking into files could cause problems such as corruption or data loss.
- Backups are also made in case the files need to be used elsewhere. The original files are then protected against possible corruption or loss.

However, backups do not necessarily guard against the effect of a virus. The virus could attach itself to the files which could mean that the backups were also affected. If the computer was 'cleaned' of the virus and then the backup files were re-loaded

there would remain the risk that the same virus could infect the computer system again. The best protection is not to get a virus in the first place (discussed in Chapter 6).

3.2 Types of access

The way data is stored and read by different backing storage devices varies considerably. This section briefly describes the two main methods of accessing data.

Serial access

With this system, to access data it is necessary to start at the beginning and then access each piece of data in turn until the required information is found.

It is primarily used on magnetic tape systems and is a very slow form of access. It is used in applications where speed of access or where the order in which the data is accessed is not important, for example in utility billing, clearing bank cheques or producing pay slips.

When a magnetic tape needs **updating**, an additional tape is required so that the old information can be **merged** with the new data (itself often on another tape, but the new data could be stored in various ways) to produce the updated tape (see Figure 3.1).

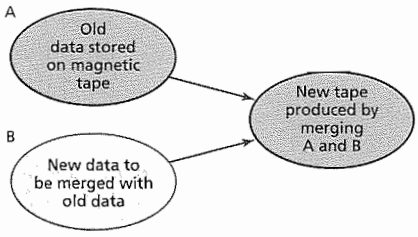


Figure 3.1 Updating the data on a magnetic tape

Direct access

This method is used with magnetic disks and with optical media (such as CDs and DVDs). The computer uses a key field to calculate where data has been stored. It is then able to access the data directly from the calculated position. Consequently, access is much faster than with serial access.

It is used in applications where access speed is vital (e.g. in **real-time process control** systems such as controlling a chemical plant or **online** systems such as booking air tickets or automatic stock control).

When updating media which uses direct access, the new data is written to the next available location and its position is calculated using the built-in algorithm.

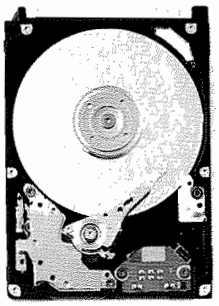
3.3 Backing storage media

Dating back to the development of the personal computer, all computer systems have come equipped with some form of backing storage. When a user types data into a computer, the information is stored temporarily on the **RAM** – however, this information would be lost as soon as the computer was turned off. Backing storage devices ensure that data is stored permanently and can be used at a later date. This section will be considering various types of backing storage and the media used.

Backing storage devices are either internal or external (i.e. plug-in devices) to the computer, and are one of three types:

- magnetic
- optical
- solid state.

Fixed hard disk



Fixed hard disk drives are available on all computers and are the main method used for data storage. On a PC this is usually a fixed hard disk with read/write heads allowing data to be written to or read from the disk surface. The disk surface is coated in a magnetic film which allows data to be stored by altering the magnetic properties to represent binary 1s or 0s (the fundamental units of computer memories). The hard drive disks usually store the **disk operating system (DOS)** and other important software and files. Applications software (e.g. spreadsheets and word processors) need a hard drive to allow them to quickly retrieve and save data.

Uses

- Fixed hard drives are used to store the operating system and working data.
- They are used for storing applications software that needs fast retrieval and storage of data.
- Real-time systems (e.g. robots, control of a chemical plant) and online systems (e.g. booking airline tickets, automatic stock control (using EPOS)) used fixed hard drives.
- They are used in file servers for computer networks.

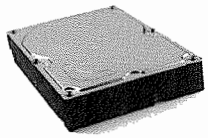
Advantages

- They have a very fast data transfer rate and fast access times to data.
- They have very large memory capacities.

Disadvantages

- They can be fairly easily damaged (e.g. if the correct shut-down procedure on a laptop computer has not been correctly carried out and the computer is then moved).
- They lack portability unless a portable hard disk drive is used (see next sub-section).

Portable hard disk drives



These devices work in much the same way as fixed hard disk drives but are usually connected to the computer via a **universal serial bus (USB)** port and can be disconnected and used on different computers. The disks are generally capable of storing more data than the equivalent optical disk (CD, DVD and so on).

Uses

- Portable hard disks can be used as back-up systems to prevent loss of data.
- They can be used to transfer data, files and software between computers.

Advantages

- The data access time and data transfer rate is very fast.
- They have large memory capacities.
- They can be used as a method of transferring information between computers.

Disadvantages

- As with fixed drives, a portable hard disk can be easily damaged if the user accidentally drops it or does not shut it down correctly after use.

Floppy disk drives

Floppy disks are still used on some computer systems. They consist of a thin disk of plastic which is housed in a plastic case with a window where the disk can be accessed. As the disk rotates, a read/write head is used to add or read data stored on the surface.

Uses

- They are still used where small files need to be transferred/stored (e.g. word-processed documents).
- Some older computer systems still make use of this method of storage.

Advantages

- Using a CD to store a small file (e.g. a word-processed document) is often regarded as wasteful – especially if CD-R is used.
- It is a very simple technology. Floppy disk drives are also extremely low cost items to buy.

Disadvantages

- Floppy disks have a very low memory capacity when compared to CD/DVDs, for example.
- Very few modern computers have floppy disk drives.
- The data transfer rate is slow compared to more modern data storage devices.
- Floppy disks are not very robust.

Magnetic tapes

A **magnetic tape** is a very thin strip of plastic which is coated in a magnetic layer. They are read and written to by a read/write head. The data is stored in magnetic areas which represent 1s and 0s. Data is written to and read from the tape in sequence (i.e. in order) – for example, if five records A, B, C, D and E were stored they would be in the order E D C B A on the tape; so if record **B** was to be read it would be necessary to read E, D and C first *before* getting to the required record. This is known as **serial access**. This type of storage is useless in a real-time or online application (due to the very slow access speeds) and is best suited to offline or batch processing.

Uses

- Magnetic tapes are used in applications where batch processing is used, for example in clearing bank cheques, utility billing (gas, electricity, water) and producing pay slips. In these applications, there is no need for any specific processing order and speed of data access is not important).
- They are used as a back-up media since all the data needs to be stored.

Advantages

- They are generally less expensive than the equivalent-capacity hard disk.
- It is a very robust technology.
- The data transfer rate is fast.

Disadvantages

- Access time is very slow.
- When updating, another tape is needed (i.e. original tape + tape with the changes produces an updated tape).

Optical storage media

Optical storage devices, such as CD and DVD, all use optical (i.e. light) read/write methods, unlike tapes and floppy/hard drive disks which are magnetic media. A laser beam is used to write to and read from the optical media.

The CDs and DVDs are manufactured either from a single polycarbonate disk or from two polycarbonate disks bonded together. A very thin layer of metal or organic dye is used as the recording media. The big advantage of these storage media is that they are portable and can store large data files (e.g. films, music or multimedia files) which would be too large for a floppy disk.

CD-ROM and DVD-ROM

CD-ROMs and DVD-ROMs are read only memory (ROM), which means they cannot be written over and can only be read. The data is stored as a series of **pits** (equivalent to a binary value of 1) and **lands** (equivalent to the binary value of 0) in the metallic optical layer. The pits are formed by a laser beam etching the surface at the manufacturing stage. Only a single track exists which spirals out from the centre of the disk.

The pits and lands are read by a low-powered laser beam which follows the data stream and reads from the centre outwards in a spiral. The light reflects differently off a pit than it does off a land and this is interpreted as 1s and 0s (i.e. data) – hence the term digital media.

Uses

- CD-ROMs are used by manufacturers to store music files and software, computer games and reference software (such as an encyclopedia).
- DVD-ROMs have much larger storage capacity than CD-ROMs and are used to store films. They are now increasingly used to store computer data and ever-more sophisticated computer and arcade games.

Advantages

- They hold far more data than floppy disks, so one CD/DVD could replace several floppy disks in some applications.
- They are less expensive than hard disk drive systems.

Disadvantages

- The data transfer rate and data access time are slower than for hard disks.

CD-R and DVD-R

The letter 'R' here means the disk is recordable *once* only and then it becomes a CD-ROM or DVD-ROM. These use a thin layer of an organic dye as the recording media; DVDs also use an additional silver alloy or gold reflector. A laser beam produces **heated spots** and **unheated spots**. On reading the disk, a laser beam is

capable of distinguishing between the two types of spots and effectively reads the data stream from the centre outwards in a spiral action. This data is then interpreted as 1s and 0s.

Uses

- They are used for home recordings of music (CD-Rs) and films (DVD-Rs).
- They are used to store data to be kept for later use or to be transferred to another computer.
- They are used in applications where it is necessary to prevent the deletion or over-writing of important data).

Advantages

- CD-Rs and DVD-Rs are cheaper than RW disks.
- Once burned (and **finalised**), they are like ROM disks.

Disadvantages

- They can only be recorded once, so if an error occurs then the disk has to be thrown away.
- Not all CD/DVD players can read CD-R/DVD-R.

CD-RW and DVD-RW

The 'RW' means that these disks are a re-writable media and can be written over several times. Unlike CD-R/DVD-R, they don't become ROMs. The recording layer uses a special phase-changing metal alloy. The alloy can switch between crystalline and amorphous (non-crystalline) phases, thus changing its reflectivity to light, depending on the laser beam power. **Spots** are produced which can be read by a laser and then interpreted as 1s and 0s. The system allows data to be written, erased and re-written many times.

Uses

- CD-RWs and DVD-RWs are used to record radio and television programmes, but can be recorded over time and time again.
- They are used in closed circuit television (CCTV) systems.

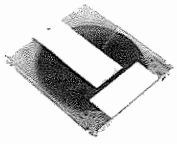
Advantages

- CD-RWs and DVD-RWs can be re-used many times.
- They can use different file formats each time they are used.
- The RW format is not as wasteful as the R format since files or data can be added at a later stage.

Disadvantages

- CD-RWs and DVD-RWs can be relatively expensive media.
- It is possible to accidentally overwrite data.

DVD-RAM



DVD-RAM is a recent addition to the optical media group. Unlike other CD and DVD formats, DVD-RAMs have several discrete concentric tracks rather than a single spiral track. This gives them the advantage that writing and reading can occur at the same time. This makes it possible to watch an already recorded television

programme at the same time as a different programme is being recorded. DVD-RAMs can be written to many times.

Figure 3.2 compares the single spiral track found on normal CDs and DVDs with the discrete single tracks found on a DVD-RAM.

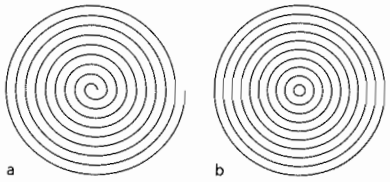


Figure 3.2 **a** Spiral tracks on a normal CD or DVD **b** Discrete tracks on a DVD-RAM

The recording layer is made from a similar phase-changing material to that used in RW technology. When writing, a laser heats the phase-changing alloy on the disk to about 500–700°C, changing the reflective properties from shiny to dull (i.e. pits). If the disk needs to be erased, a laser heats the surface to about 200°C to return the disk to its original shiny state. A low power laser is used to read the written marks on the surface. The shiny and dull (pits) marks represent data to a computer where they are interpreted.

Uses

- DVD-RAMs are used in recording devices such as satellite receivers to allow simultaneous recording and playback.
- They are used in camcorders to store films.

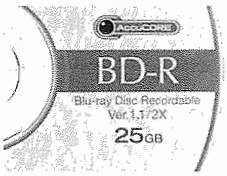
Advantages

- DVD-RAMs have a long life – minimum life is estimated to be 30 years.
- It is possible to do a re-write operation over 100,000 times, compared with the RW format which only allows about 1,000 re-writes.
- Writing on DVD-RAMs is very reliable, as they have in-built verification software to ensure the accuracy of the data.
- Access is very fast if the files are fairly small.
- There is no need to finalise the disk.
- They have a very large capacity (about 10 Gbyte if double-sided format is used).
- They offer the ability to read data at the same time as data is being written.

Disadvantages

- DVD-RAMs are not as compatible as R or RW format, as many systems will not recognise their format.
- They are relatively expensive, costing about 4 times as much as a DVD-RW disk.

Blu-ray disks



Blu-ray disks have the largest capacity of all the optical media available and go up to 100 Gbyte (at the present time). The laser beam used is at the blue/violet end of the spectrum, rather than red which is the colour of the lasers used in other optical media. Consequently, the light used has a shorter wavelength, allowing more data to be stored/read on the disk.

Uses

- Blu-ray disks are used in home video consoles.
- They are used for storing and playing back films: 1 high-definition film of two hours duration uses 25 Gbyte of memory.
- PCs can use this technology for data storage or backing up hard drives.
- Camcorders can use this media (in cartridge form) to store film footage.

Advantages

- They have a very large storage capacity, and so are ideal for storing high definition films.
- The data transfer rate is very fast.
- The data access speed is also greater than with other optical media.

Disadvantages

- The disks are relatively expensive .
- At the time of writing, blu-ray systems still have encryption problems (which are used to stop piracy) when used to store video.

Solid state backing store

Solid state technology is being developed to the point where solid state drives will soon replace hard disk drives in laptop computers. This is due to their inherent thinness, their much faster data access time and the fact that they are extremely robust.

They are similar to magnetic and optical media in that data is still stored as 1s and 0s. However, instead of changing the magnetic properties on the thin film surface of a rotating disk, these solid state systems control the movement of electrons within a microchip. The 1s and 0s are stored in millions of miniature transistors within the microchip: if the transistor conducts a current, this is equivalent to a 1, otherwise it is a 0.

They consequently have no moving parts, consume much less power and are extremely robust.

They are used primarily as removable storage devices and are collectively known as flash memory. The most common examples are memory sticks/pen drives and memory cards.

Memory sticks/pen drives

Memory sticks/pen drives can store several Gbytes of data and use the solid state technology described above. They are usually connected to a computer through the USB port and power to operate them is drawn from the host computer. They are extremely small and very portable. Most operating systems recognise these storage media, which means that no additional software is needed to operate them.

Some expensive software increasingly use these storage methods (sometimes referred to as portable flash drives) as a form of security. They plug into the computer using the USB port and are known as **dongles**. The software installed on a computer sends out a request (in encrypted form) to the dongle asking for an encrypted validation key. Thus a person trying to commit **software piracy** would have to crack the code on the dongle first before they could use the software. Some systems go one stage further and have key bits of software stored on the dongle in encrypted form. The software looks for these pieces of encrypted code to enable it to run. This gives an added security benefit to the software.

Uses

- Memory sticks and pen drives are used for transporting files between computers or as a back-up store.
- They are used as a security device – a dongle – to prevent software piracy.

Advantages

- They are very compact and portable media.
- They are very robust.

Disadvantages

- It is not possible to write protect the data and files.
- Their small physical size means that they are easy to lose.

Flash memory cards

These are a form of **electrically erasable programmable read only memory** (EEPROM) and are another example of solid state memories.

Uses

- Flash memory cards are used to store photos on digital cameras.
- Mobile phones use them as memory cards.
- They are used in **MP3** players to store music files.
- They are used as a back-up store in handheld computer devices.

Advantages

- Flash memory cards are very compact, so they can be easily removed and used in another device or used for transferring photos directly to a computer or printer.
- Since they are solid state memories, they are very robust.

Disadvantages

- They are expensive per Gbyte of memory when compared to hard drive disks.
- They have a finite life in terms of the number of times they can be read from or written to.
- They have a lower storage capacity than hard disks.

CHAPTER 4

Computer networks

In this chapter you will learn about:

- types of networks:
  - ring, bus, star and tree
  - local area networks (LANs), wide area networks (WANs) and wireless LANs (WLANs)
- network devices – modems, hubs and switches, routers and bridges
- the internet – web browsers and internet services providers (ISPs)
- intranets
- network security – user IDs, passwords, encryption and authentication techniques
- communications – fax, email, video conferencing and voice over internet protocol (VOIP).

4.1 Introduction

Most computer systems are now connected together in some way to form what is known as a **network**. This ranges from the basic school/home network of only a few computers (often set up to share resources such as printers or software) to large networks such as the **internet** which effectively allows any computer connected to it to communicate with any other computer similarly connected.

This chapter considers the types of networks that exist and the many features that are available because of networking.

4.2 Common types of network

Most networks are controlled by the use of **servers**. There are different types of servers, for example:

- **file servers**, which allow users to save and load data/files
- **applications servers**, which deal with the distribution of applications software to each computer
- **printer servers**, which ensure printing from devices on the network is done in a queue, for example
- **proxy servers**, which are used as a buffer between WANs (discussed at the end of this section) and LANs (discussed in Section 4.3).

This section will now describe a number of different types of networks.

Local area networks

A **local area network** (LAN) is usually within one building or certainly not over a large geographical area. A typical LAN will consist of a number of computers and devices (e.g. printers) which will be connected to **hubs** or **switches**. One of the hubs or switches will usually be connected to a **router** and **modem** (usually **broadband**) to allow the LAN to connect to the internet; in doing so it then becomes part of a **wide area network** (WAN).

There are advantages of networking computers together using LANs:

- the sharing of resources (such as expensive peripherals and applications software)
- communication between users
- a network administrator to control and monitor all aspects of the network (e.g. changing passwords, monitoring internet use and so on).

However, there are also disadvantages:

- easier spread of viruses throughout the whole network
- the development of printer queues, which can be frustrating
- slower access to external networks, such as the internet
- increased security risk when compared to stand-alone computers
- the fact that if the main server breaks down, in most cases the network will no longer function.

There are four common types of LAN network **topologies**: ring, bus, star and tree networks.

Ring networks

Ring networks, shown in Figure 4.1, are becoming less popular. Every computer in the network is connected in a ring, including the server. Data is transmitted around the ring and each computer only removes the data which is relevant to it. This allows each computer to send and receive data since they all have a unique identification/address.

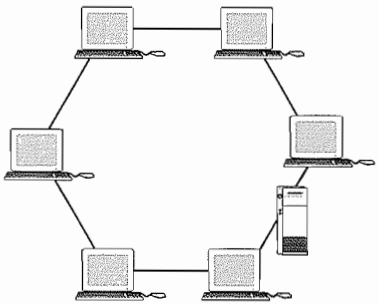


Figure 4.1 A ring network

Advantages

- Ring networks work well under heavy loading.
- It is possible to create very large networks using this topology.

Disadvantages

- If there is a fault in the wiring between two computers then the whole network will fail.
- Adding a new device or computer to the network can be difficult since it has to be placed between two existing devices.

Bus networks

In a **bus network**, illustrated in Figure 4.2, each computer or device is connected to a common central line. Data travels along this central line until it reaches the computer or device that requires it. The ends of the line have terminators to prevent, for example, signal bounce, which would cause data interference.

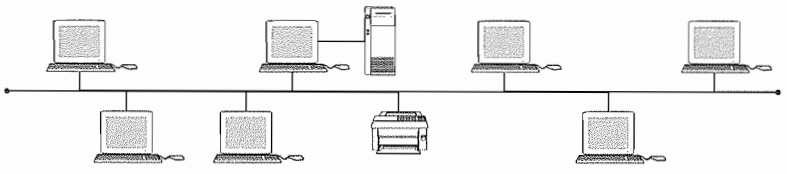


Figure 4.2 A bus network

Advantages

- It is easy to add a new computer or device to the network.
- If one device or computer fails, it does not affect the rest of the network.
- This type of network doesn't need a hub or a switch and also requires less cabling than, for example, a star network. It therefore also saves on costs.

Disadvantages

- It is difficult to isolate any fault on the network.
- If the central line has a fault then the whole network fails.
- This is becoming an increasingly outdated topology for network design.
- Its performance worsens noticeably as more and more devices/ computers are added.

Star networks

With a **star network**, shown in Figure 4.3, each computer or device is connected via a central hub or switch. Data is sent to the hub which then sends out data along *every* cable to every computer or device (no checking is done to see where the data should be sent).

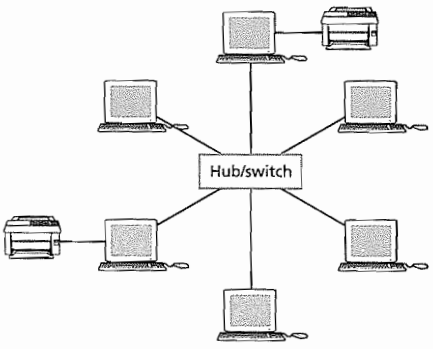


Figure 4.3 A star network

Advantages

- If one computer or device fails, then the rest of the network is unaffected.
- Problems on the network are easy to identify and work can be carried out on a faulty device without affecting the rest of the network.
- It is easy to expand the network.

Disadvantages

- If the central hub breaks down, the whole network crashes.

Tree network

A **tree network** has a central line (just like a bus network) connecting together a series of star networks, as shown in Figure 4.4. The server is also connected to this central line. Because of its flexibility, and the fact that it has the advantages of both bus and star networks, this topology is becoming increasingly popular.

The advantages and disadvantages are the same as for bus and star networks.

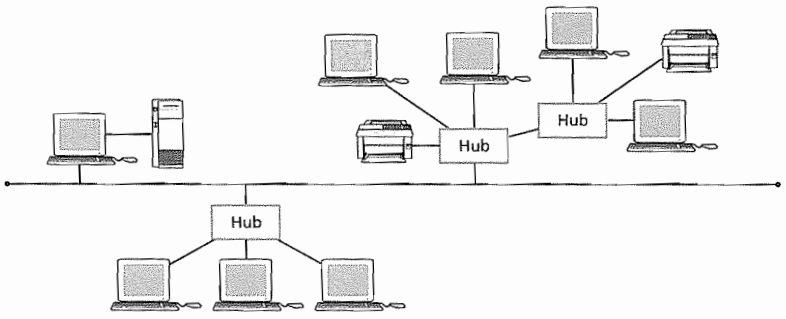


Figure 4.4 A tree network

Wireless LANs (WLANs)

WLANs are similar to LANs but there are no wires or cables. In other words, they provide wireless network communications over fairly short distances (a few metres) using radio or infrared signals instead of cables.

Devices, known as **access points (APs)**, are connected into the wired network at fixed locations (see Figure 4.5). Because of the limited range, most commercial WLANs (e.g. on a college campus or at an airport) need several APs to permit uninterrupted wireless communications. The APs use either **spread spectrum technology** (which is a wideband radio frequency with a range of about 30 to 50 metres) or **infrared** but this has a very short range (i.e. about 1 to 2 metres) and is easily blocked, so is of limited use.

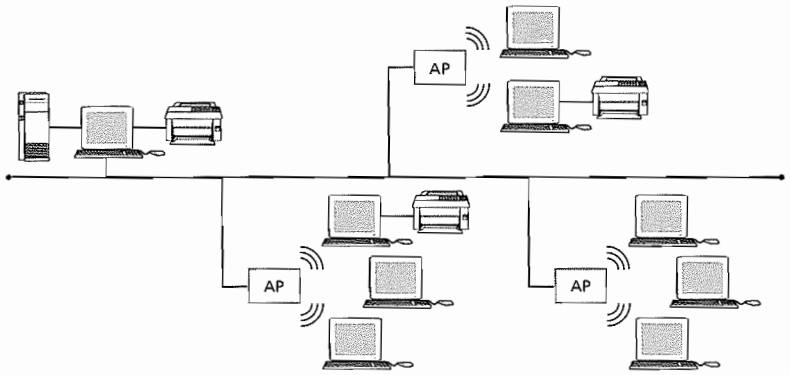


Figure 4.5 A network connecting WLANs

The AP receives and transmits data between the WLAN and the wired network structure. End users access the WLAN through WLAN adapters, which are built into the devices or are plug-in modules.

Advantages

- All computers can access the same services and resources (e.g. printers, scanners, internet access from anywhere within range of the APs).
- There is no cabling to individual computers and devices so safety is improved.
- The system is more flexible, since users can move their laptops from their desks.
- Adding new computers and devices is very easy (all that is required is a WLAN adapter, provided the device is within range of an AP) and costs are reduced since no extra cabling is needed.

Disadvantages

- Security is a big issue since anyone with a WLAN-enabled laptop computer can access a network if it can pick up a signal. It is therefore necessary to adopt complex data encryption techniques.
- There may be problems of interference which can affect the signal.
- The data transfer rate is slower than in a wired LAN.

WiFi

WiFi refers to any system where it is possible to connect to a network or to a single computer through wireless communications, for example:

- on the WLAN described above
- PDAs and other handheld devices

- laptop computers which are WiFi enabled
- peripheral devices such as printers, keyboards and mouse which can interface with the single computer when fitted with WiFi adapters.

WiFi systems rely on some form of AP, which uses radio frequency technology to enable the device to receive and send signals.

Note that WiFi is *not* short for wireless fidelity (a common misconception!). Rather, it is the trademark name for any product which is based on the **IEEE 802.11** standard.

WiFi **hotspots** are places where you can access WiFi (free or paid). They exist in public places such as airports, hotels and internet cafés. It is possible to logon to free WiFi hotspots unless they are protected by passwords. Software exists which can be loaded onto a laptop computer which then searches for non-protected WiFi systems. The practice of driving around in a car looking for these unsecured WiFi hotspots is known as **war driving** and poses a security risk to any unsecured WiFi system.

Bluetooth

Bluetooth is an example of **wireless personal area networking (WPAN)** technology. Spread spectrum transmission (radio waves) is used to provide wireless links between mobile phones, computers and other handheld devices and allow connection to the internet.

With this system, it is possible to create a small home network, for example, to allow communication between any PDA, mobile phone, computer, media player and printer. The range is, however, quite small (about 10 metres). Examples of its use include the transfer of photographs from a digital camera to a mobile phone or the transfer of phone details to a computer. It behaves like a mini-LAN.

Wide area networks

A wide area network (WAN) is basically formed by a number of LANs being connected together through either a router or a modem. Some companies will set up private WANs (usually by way of fibre optic cabling or telephone wires restricted to company use only). This is expensive but comes with the advantage of much enhanced security. It is more common to use an **internet service provider (ISP)** for connections to the internet and communicate via this network system.

The following additional hardware is needed for a WAN: routers, modems and **proxy servers** (described in Section 4.3).

4.3 Network devices

Modems

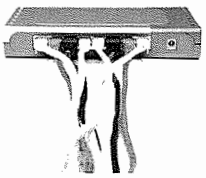
Modem means *mo*dulator *dem*odulator and is a device which converts a computer's digital signal (i.e. modulates it) into an analogue signal for transmission over an existing telephone line. It also does the reverse process, in that it converts analogue signals from a telephone line into digital signals (demodulates) to enable the computer to process the data. (Section 5.5 discusses digital and analogue data in more detail.)

Modems are used to allow computers to connect to networks (e.g the internet) over long distances using existing telephone networks.

Dial-up modems operate at transmission speeds of about 60 kilobits per second, which is quite slow by today's standards. (These are discussed in more detail in Section 4.4.) However, modern broadband or **asymmetric digital subscriber line (ADSL)** modems operate at 11,000 kilobits per second (or higher). The term 'asymmetric' means that the modem is faster at **downloading** (getting) data than it is **uploading** (sending) data.

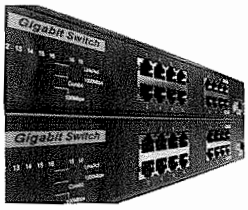
Although the ADSL modems still use the existing telephone network, unlike dial-up modems they do not tie up the line while accessing the internet, so the land-line telephone can still be used at the same time. Furthermore, they can always be 'on' so internet access can be available 24 hours a day. ADSL modems can allow telephone conversations and internet traffic to occur at the same time because of the wide bandwidth signal used: the higher frequencies are used to carry the internet signals, so they do not interfere with normal telephone traffic. Cable modems also exist which allow cable television providers to offer internet access as well as receiving television signals.

Network hubs



Network hubs are hardware devices that can have a number of devices/computers connected to them. Its main task is to take any data received via one of the ports and then send out this data from all of the ports. Each computer/device will receive the data, whether it is relevant or not.

Switches



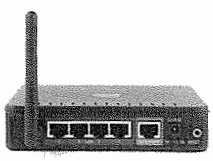
Switches are similar to hubs but are more efficient in the way they distribute data. A hub learns which devices are connected to which ports. Each device has a **media access control (MAC) address** which identifies it uniquely. **Data packets** sent to the switch will have a mac address giving the source and receiving device. If a device X is always sending the switch data via port 4 then it learns that X must be connected to that port; any data packet which is intended for X only is then sent through port 4 and not through any of the others. This means that the network traffic only goes to where it is needed and so a switch is more efficient than a hub, especially when the network is very busy.

Bridges

Bridges are devices that connect one LAN to another LAN that uses the same **protocol** (the rules that determine the format and transmission of data). They decide whether a message from a user is going to another user on the same LAN or to a user on a different LAN. The bridge examines each message and passes on those known to be on the same LAN and forwards messages meant for a user on a different LAN.

In networks that use bridges, workstation addresses are not specific to their location and therefore messages are actually sent out to every workstation on the network. However, only the target workstation accepts this message. Networks using bridges are interconnected LANs since sending out every message to every workstation would flood a large network with unnecessary traffic.

Routers



Since large companies often have more than one network there are occasions when the computers in one network want to communicate with the computers in one of the other networks. Routers are often used to connect the LANs together and also connect them to the internet.

Routers inspect the data packages sent to it from any computer on any of the networks connected to it. Since every computer on the same network has the same first part of an **internet protocol (IP) address**, the router is able to send the data package to the appropriate switch and it will then be delivered using the mac destination address in the data packet. If this mac address doesn't match any device on the network it passes on to another switch on the same network until the device is found.

HTTP proxy servers

This is a special type of server that acts as a buffer between a WAN (usually the internet) and a LAN. The server passes on the service requests to the internet and then passes back the requested pages. It therefore retrieves web pages and passes them on to the computer that made the request. Any page retrieved from the internet is stored on the server, which means that when a different computer requests the same page it is available immediately thus considerably speeding up the browsing process.

4.4 The internet

The internet is a worldwide collection of networks which allows a subscriber to send and receive emails, chat (using text or voice) or browse the world wide web.

The **world wide web (WWW** or **web)** is the part of the internet which the user can access by way of a **web browser** (e.g. Microsoft Internet Explorer). A web browser is software that allows the user to display and interact with pages and files from the web.

Websites

The web is made up of millions of these **websites** (e.g. www.hoddereducation.com) and millions of **web pages** (e.g. Hodder Education front page, shown in Figure 4.6). Web pages are documents on a computer screen which may consist of text, pictures, sounds, animation or video (i.e. multimedia). A website consists of many of these pages linked together.

Figure 4.6 Example of a web page

The website shows these **hyperlinks** to allow users to **navigate** between web pages. These hyperlinks are often shown as blue underlined text or sometimes a small hand appears under a picture or under some text indicating the link to another page or website. The user clicks on these hyperlinks using a mouse (or other pointing device) to move to another page.

Web browsers use uniform resource locations (URLs) to retrieve files. URLs are a standard way of locating a resource on the internet; they are usually a set of four numbers, e.g. 194.106.220.19. However, as this can be difficult to remember, an alphanumeric form is usually used which has the format:

protocol://site address/path/filename

where:

- **protocol** is usually http
- **site address** consists of: host computer name, domain name, domain type and (very often) the country code:
  - **computer name** is usually www
  - **domain name** is the name of the website
  - **domain type** is commonly one of the following: .com, .org, .co, .net, .gov
  - examples of **country code** include .uk, .us, .de, .cy
- **path** is the web page
- **filename** is the item on the webpage.

Thus, a full URL could be http://www.urlexamples.co.cy/pages/example1

Accessing the internet

An ISP is a company that provides users with access to the internet, usually for a fee. When a user registers with an ISP, an account is set up and they are given **login** details, which include a **username** and a **password**. The user connects to the internet via the user account which also allows the provider to monitor usage. Most ISPs also provide an **email** account (see Figure 4.7 for an example of an email page).

Figure 4.7 Example of an email page

Emails are an electronic way of sending documents (etc.) from one computer to another. They allow **attachments**, which can be word-processed documents, spreadsheets, data files, music files, movie files, etc. An email address contains two parts:

example1@yahoo.co.uk OR example2@yahoo.com

The first part is the user name e.g. **example1** or **example2** and the second part is @ followed by host name e.g. **@yahoo.co.uk** or **@yahoo.com**.
Emails are discussed in more depth in Chapter 9.

There are three common ways of accessing the internet offered by service providers:

- dial-up internet access
- cable internet access
- digital subscriber line (DSL) (broadband) internet access.

These were discussed in Section 4.3 as part of modems and are summarised in Table 4.1.

Type of access	Description
Dial-up internet access (dial-up modem)	This is the slowest type of connection (about 60 kbps). The user connects to the internet via the telephone line by dialling one of the numbers supplied by the ISP. They are therefore not on all the time; ISP contracts are usually for a number of hours per month of internet access time and additional charges are incurred if this is exceeded. A big disadvantage is that the telephone line is tied up while a dial up modem is in operation.
Cable internet access (cable modem)	Local cable television operators give a user access to the internet through their own cable networks using a cable network modem.
Internet access via DSL (broadband modem)	The fastest download speeds can be obtained by using DSL broadband connections (at least 11,000 kbps). This is often offered with wireless interface which requires an AP and a router. ISPs usually have a download/upload limit (e.g. 20 Gbyte of data) as part of the contact. This is not a problem unless the user is often downloading music or movie files which can quickly use up the memory allocation. Broadband has the advantage of always being on, since it doesn't tie up the telephone line. The fast transfer rate allows systems such as **voice over IP (VOIP)** and online chat rooms to be used effectively.

Table 4.1 Methods of accessing the internet

4.5 Intranets

Many companies use an **intranet** as well as the internet. The simple definition of an intranet is 'a computer network based on internet technology that is designed to meet the internal needs for sharing information within a single organisation/company'. There are number of reasons for doing this.

- It is safer since there is less chance of external hacking or viruses.
- It is possible to prevent employees from accessing unwanted websites.
- Companies can ensure that the information available is specific to their needs.
- It is easier to send out *sensitive* messages that will remain only within the company.

It is now worth comparing the internet with intranets:

- The term 'internet' comes from the phrase *inter*national *net*work.
- The term 'intranet' comes from the phrase *int*ernal *r*estricted *a*ccess *net*work.
- An intranet is used to give local information relevant to the company whereas the internet covers topics of global interest.
- It is possible to block out certain internet sites using an intranet. This is much more difficult to do from the internet.
- An intranet requires password entry and can only be accessed from agreed points, whereas the internet can be accessed from anywhere provided the user has an ISP account.

- An intranet is behind a firewall, which gives some protection against **hackers** (unauthorised users), viruses and so on. This is much more difficult to do with internet access since it is more open on an international scale.
- Information used in intranets is usually stored on local servers, which makes it more secure from outside agencies.

4.6 Network security

The security problems when using networks such as the internet are well documented. There are various security threats to networks and there are many equally varied ways of combating the threat. Many of these issues are discussed in Chapter 6 but this section will concentrate on four areas:

- user ID
- password
- encryption
- authentication techniques.

User IDs

When logging on to any network system, a user will be asked to type in a **user ID**. This assigns the user privileges once the logon procedure is successful. For example, on a network, top level **privilege** would be for an **administrator**, who is able to set passwords, delete files from the server, etc., whilst a user privilege may only allow access to their own work area.

Passwords

After keying in the user ID, the user will then be requested to type in their **password**. This should be a combination of letters and numbers which would be difficult for somebody else to guess. When the password is typed in it often shows on the screen as ******** so nobody overlooking can see what the user has typed in. If the user's password doesn't match up with the user ID then access will be denied. Many systems ask for the password to be typed in twice as a **verification** check (check on input errors). To help protect the system, users are only allowed to type in their password a finite number of times – three times is usually the maximum number of tries allowed before the system locks the user out. After that, the user will be unable to logon until the system administrator has re-set their password.

When using some internet websites, if a user forgets their password they can request the password to be sent to their email address. The password is never shown on the computer screen for reasons of security.

Encryption

Encryption is the converting of data into a code by scrambling it or **encoding** it. This is done by employing encryption software (or an encryption key). Since the data is all jumbled up it appears meaningless to a hacker or anyone who illegally accesses the data. It should be stressed that this technique *does not* prevent illegal access, it only makes the data useless to somebody if they don't have the necessary decryption software (or decryption key). It is used to protect sensitive data (such as a person's banking details).

The system works like this:

- A user writes a message and the computer sending this message uses an encryption key to encode the data. For example, the message 'THIS IS AN EXAMPLE' (sent on 15 April) is encoded to '43Kr Kr T7 W04887W'.
- At the other end, the receiving computer has a decryption key which it uses to decode the message. Note that the date when the message was sent is important since this formed part of the encryption **algorithm**.

Encryption keys are much more complex than the one above, in order to prevent computers being used to crack the code. Very sophisticated algorithms are used which make the codes almost unbreakable.

Authentication techniques

As shown above, there are many ways in which a computer user can prove who they are. This is called **authentication**, and a type of authentication is used in the banking example that follows. Most systems adopt the following authentication logic:

- something you know – e.g. PIN/password
- something belonging to you – e.g. your bank card
- something unique to you – e.g. your fingerprints.

At least two of these are needed at the moment when a user has to prove who they are. For example, the following banking example uses:

- something you know – surname, reference number, PIN, date last logged on
- something belonging to you – card put into card reader to produce the 8-digit code.

In future, the third feature will be introduced (such as a fingerprint scanner attached to a computer to uniquely identify the user).

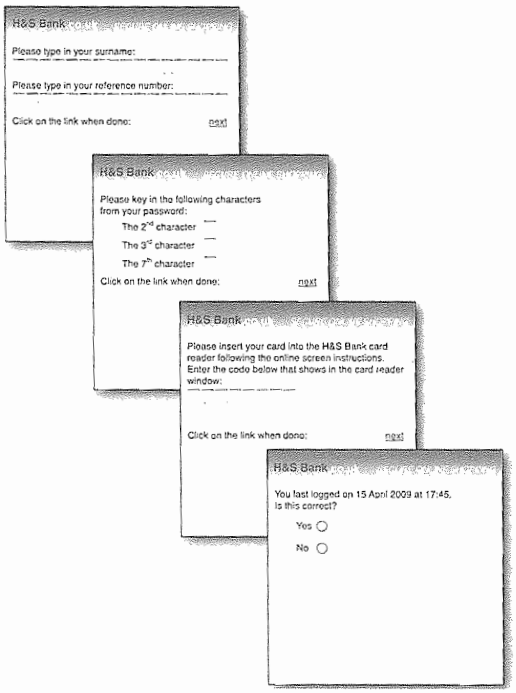


Figure 4.8 The authentication process

Banking example

A user belongs to H&S Bank. He wants to check the status of his account online. He logs onto the H&S Bank website using his ISP. Figure 4.8 illustrates a sophisticated set of steps taken to prevent unauthorised access.

Only once each page has been successfully navigated will the user have access to his bank account. The last stage is a final check to see if the customer's account has been illegally accessed – if they hadn't logged into the website on 15 April at 17:45 then this would trigger a security check into the customer's account. Note that the last web page makes use of what are called **radio buttons**.

4.7 Communication methods

Many methods of communication using networks exist. These include **fax**, email, **video conferencing** and VOIP.

Fax

The term **fax** is short for the word 'facsimile'. With this system, documents are scanned electronically and converted into a **bit map** image (a bit is a *b*inary dig*it* and is a 1 or a 0). This is then transmitted as a series of electrical signals through the telephone network. The receiving fax machine converts this electronic image and prints it out on paper.

It is also possible to generate fax signals from a computer to allow files and documents to be sent to a fax machine – this saves printing out the document first and then passing it through a fax machine. Fax/modem software in the computer converts the image into a form recognised by a fax machine. However, this is not as efficient as the email system where the electronic copy is sent and is then stored electronically thus permitting the document to be edited, for example.

Email

This is an electronic method for sending text and attachments from one computer to another over a network (see Section 4.4 for further details).

The advantages of using email include:

- the speed of sending and receiving replies using the email system
- the low cost, since stamps, paper and envelopes are not needed
- not needing to leave home to send the mail.

Disadvantages include:

- the possibility of virus threats and hacking
- the need for the email address to be completely correct
- the inability to send bulky objects via emails.

Video conferencing

This is a method of communication between people at two separate locations (e.g. in different countries). This is done in **real time** and makes use of a LAN, if internal, or through a WAN, e.g. the internet, if national or international. The system works in real time and uses additional hardware such as webcams, large monitors/television screens, microphones and speakers.

The system also uses special software such as:

- CODEC, which converts and compresses analogue data into digital data to send down digital lines
- echo cancellation software, which allows talking in real time and synchronises communications.

Delegates at one end speak into a microphone and look at a webcam. The other delegates can see them and hear them using large monitors and speakers.

There are potential problems with these systems such as time lag (the time it takes for the signal to reach its destination, which can be difficult when trying to have a conversation since there seems to be a delay). Also, sound quality and picture quality can be poor unless expensive hardware and software is used.

However, these systems are becoming increasingly popular as the cost of travelling increases and the risk of terrorist attacks becomes higher. One large company, which reduced travelling from Europe to USA and used video conferencing wherever possible to discuss product development, claims to have saved several million US dollars over a 12-month period. The savings were due to reduced travelling (mostly air fares) and to reduced overnight accommodation. Since little or no travelling is involved meetings can be held at short notice, but time differences between countries can become an issue.

VOIP

Voice over internet protocol (VOIP) is a method used to talk to people using the internet. VOIP converts sound (picked up by the computer microphone or special VOIP telephone plugged into the USB port of the computer) into discrete digital packets which can be sent to their destination via the internet. One of the big advantages is that it is either free (if the talking is done computer to computer, i.e. both computers have VOIP telephones or use their built-in/plugged-in microphones and speakers) or at a local rate to anywhere in the world (when VOIP is used to communicate with a mobile or land line telephone rather than another computer).

To work in real time this system requires a broadband ISP. The main problems are usually sound quality (echo and 'weird sounds' are both common faults). Security is also a main concern with VOIP, as it is with other internet technologies. The most prominent security issues over VOIP are:

- identity and service theft
- **viruses** and **malware** (malicious software)
- **spamming** (sending **junk mail**)
- **phishing** attacks (the act of sending an email to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft).

CHAPTER 5

Data types

In this chapter you will learn about:

- types of data – Boolean, text, alphanumeric, numeric and date
- data structures – files, records, fields and primary keys
- relational databases – tables, primary keys and foreign keys
- analogue data – the need for analogue to digital convertors (ADC)
- digital data – the need for digital to analogue convertors (DAC).

5.1 Introduction

Data can exist in many forms, and so there are various defined types of data that computers use. All the data that is stored on computers is digital, but lots of types of data in the real world involve physical measurements of continuously varying data. These need to be converted into digital data for storage and manipulation on a computer.

Data frequently needs to be stored in a logical sequence to allow access and/or searching to be done at some later stage. One of the most common methods of data storage is the use of databases.

5.2 Types of data

There are several data types found in most computer systems:

- logical/Boolean
- alphanumeric/text
- numeric
- date.

Logical/Boolean data

Boolean data (or logic data type) can have only two values: **true** or **false**. This works if there are only two possible responses to a question or situation, i.e. (Yes or No), (True or False) or (1 or 0).

This is made most use of when carrying out a search in a database or on the internet. In these cases, **logical operators** are used which are based on true (i.e. binary 1) or false (i.e. binary 0) logic.

The AND operator

Consider the list of seven students in Table 5.1.

Name	Sex	Height (m)
A	Male	1.6
B	Male	1.7
C	Female	1.5
D	Female	1.7
E	Male	1.4
F	Female	1.6
G	Male	1.5

Table 5.1 A small database

Suppose we now make the search:

(Sex = Male) AND (Height (m) > 1.6)

Table 5.2 shows the logic status for each part of the search query. There is only one match where the search condition is **true** for (Sex = Male) AND **true** for (Height (m) > 1.6): name B.

Name	Sex	Sex logic status	Height (m)	Height logic status
A	Male	True	1.6	False
B	Male	True	1.7	True
C	Female	False	1.5	False
D	Female	False	1.7	True
E	Male	True	1.4	False
F	Female	False	1.6	False
G	Male	True	1.5	False

Table 5.2 Logic status for search query (Sex = Male) AND (Height (m) > 1.6)

Note that the logic operator called AND looks for the situation where something is **true** in *both* groups. For example, consider two groups X and Y where X = {1, 2, 3, 4} and Y = {3, 4, 5, 6}. The statement X AND Y would be equal to {3, 4} since it is true that 3 and 4 are the only items which are common (i.e. true) to both groups (see Table 5.3).

Number	Number is in group X	Number is in group Y
1	True	False
2	True	False
3	True	True
4	True	True
5	False	True
6	False	True

Table 5.3 Logic status for statement X AND Y

In the student database only example B contains items which are true (common) to both groups (i.e Male *and* 1.7m).

The OR operator

Now consider a different search:

(Sex = Female) OR (Height (m) < 1.6)

This gives the logic status shown in Table 5.4. There are five matches where the search condition is **true** for (Sex = Female) OR **true** for (Height (m) < 1.6): names C, D, E, F and G.

Name	Sex	Sex logic status	Height (m)	Height logic status
A	Male	False	1.6	False
B	Male	False	1.7	False
C	Female	True	1.5	True
D	Female	True	1.7	False
E	Male	False	1.4	True
F	Female	True	1.6	False
G	Male	False	1.5	True

Table 5.4 Logic status for search query (Sex = Female) OR (Height (m) < 1.6)

Note that the logic operator called OR looks for the situation where something is **true** in *either* group. For example, consider two groups X and Y where X = {1, 2, 3, 4} and Y = {3, 4, 5, 6}. The statement X OR Y would be equal to {1, 2, 3, 4, 5, 6} since it is true that all six numbers occur in either group (see Table 5.5).

Number	Number is in group X	Number is in group Y
1	True	False
2	True	False
3	True	True
4	True	True
5	False	True
6	False	True

Table 5.5 Logic status for statement X OR Y

In the student database example, C, D, E, F and G contain items which are true in either group.

Alphanumeric and text data

Looking at a standard keyboard, you see the letters A to Z, the digits 0 to 9 and other characters such as : @ & £) } etc. The letters A to Z are referred to as **text** and the letters A to Z *plus* the digits 0 to 9 are referred to as **alphanumeric** (some definitions also include the remaining keyboard characters such as @ & £) } as part of the alphanumeric character set).

For example, the password 'MARQUES' contains letters only and is therefore text. However, the password 'MIKE62' contains letters and numbers and is therefore alphanumeric. A person's name would always be text but their address, which could contain letters and numbers, would be alphanumeric.

Numeric data

Numeric data can be in two forms: **integer** (whole numbers) or **real** (containing decimals). For example, 3416 is an integer, but 34.16 is real.

Examples of integers include the number of floors in a hotel, the number of students in a class or the number of wheels on a car. Examples of real numbers include temperatures, price of an item in a shop or a person's height in metres. Numeric data also includes zero (0) and negative numbers such as – 4516 (integer) or – 30.26 (real).

Date data

Date can be written in many forms, for example:

- dd/mm/yyyy (dd = day, mm = month and yy/yyyy = year), e.g. 19/08/2009
- dd/mm/yy, e.g. 19/08/09
- dd.mm.yy, e.g. 19.08.09
- yyyy-mm-dd, e.g. 2009-08-19.

All of the above examples use a number form of the month, but it can also be written as the full word or the three-letter abbreviation:

- dd mmmm yyyy, e.g. 19 August 2009
- dd-mmm-yyyy, e.g. 19-Aug-2009.

All the above are accepted as date in most application packages (such as spreadsheets and databases) where the format is particularly important due to data manipulation (e.g. sorting) or searching.

5.3 Data structures

Data is often stored in **files**, which consist of **records**, which in turn consist of **fields**, as illustrated in Figure 5.1.

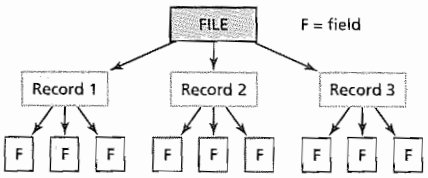


Figure 5.1 Structure of a data file

For example, a company may have set up a file to include information about their employees in the following format:

reference number/name/date started/department

Figure 5.2 shows a possible structure for the file COMPANY EMPLOYEE FILE. The information is held in one file with five records and four fields per record. In this example, the first field (the reference number) is known as the **key field** or **primary key**. Each primary key is unique and is used to locate a record in a file during a search operation.

Record 1	1416	J. Smith	30/05/2003	Sales
Record 2	1417	K. Shah	11/02/1989	Manager
Record 3	1431	R. Marques	15/10/2001	Finance
Record 4	1452	T. Rodriguez	27/09/1995	Sales
Record 5	1461	V. Schultz	09/12/2005	Graduate
	field	field	field	field

FILE

Figure 5.2 The file 'COMPANY EMPLOYEE FILE'

Also note the data types for each field:

reference number	numeric data (integer)
name	text
date	date format (dd/mm/yyyy)
department	text

In reality, COMPANY EMPLOYEE FILE would be much larger, containing all the records for all the company's employees. This type of file is often referred to as a **flat file structure**.

5.4 Databases

A **database** is a collection of information which is structured in some way to permit manipulation and searching of data.

Why are databases used?

- They promote data consistency. When data is updated on a database it is up to date for *any* application which uses the database.
- Data duplication is reduced to a minimum since only one copy of each data item needs to be kept.
- It is relatively easy to expand the database if some new application is being considered.

- Security of data is easier to monitor and maintain. Data access can be controlled by database **front ends**; the actual database will be 'invisible' to all users except the database administrator (see Figure 5.3).

Early databases were examples of flat file structures, as described in Section 5.3 and illustrated by the COMPANY EMPLOYEE FILE. The way the data is organised makes it difficult to search for a specific piece of information or to create **reports** which only contain certain information (fields) from each of the records.

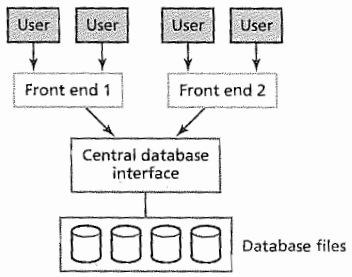


Figure 5.3 User access to data contained in a database

Relational databases

Relational databases were first introduced in 1970 following the work of F. F. Codd, a researcher at IBM.

Relational databases consist of a number of separate **tables** which are related (a table is made up of rows and columns in much the same way as a spreadsheet is structured). Each table contains a primary (key) field that is also a field in at least one other table. It is possible to combine data from different tables to produce a report which only contains the required information.

Relational databases do not need to repeat data, which is one of the problems of flat file structure (in the example that follows, three flat files would be needed containing repeated fields of key data since there would be no links connecting each file). Information is stored in separate tables only connected by the primary (key) field. Other advantages of relational databases include:

- faster data retrieval (because of links between tables)
- easy expansion of the database by adding extra data or new tables
- the need to change data in only one table – all other references to this data will then also be up to date, resulting in what is known as **data integrity**.

Tables can also contain **foreign keys** that relate tables in the database to one another. A foreign key in one table is a primary key in another.

We will now look at an example that shows the structure of tables in a relational database. In this example, there are three connected tables. It is important to note that in commercial databases there will be several tables connected together. The examples shown here contain only two or three and are being used to show the principle of relational databases.

Example

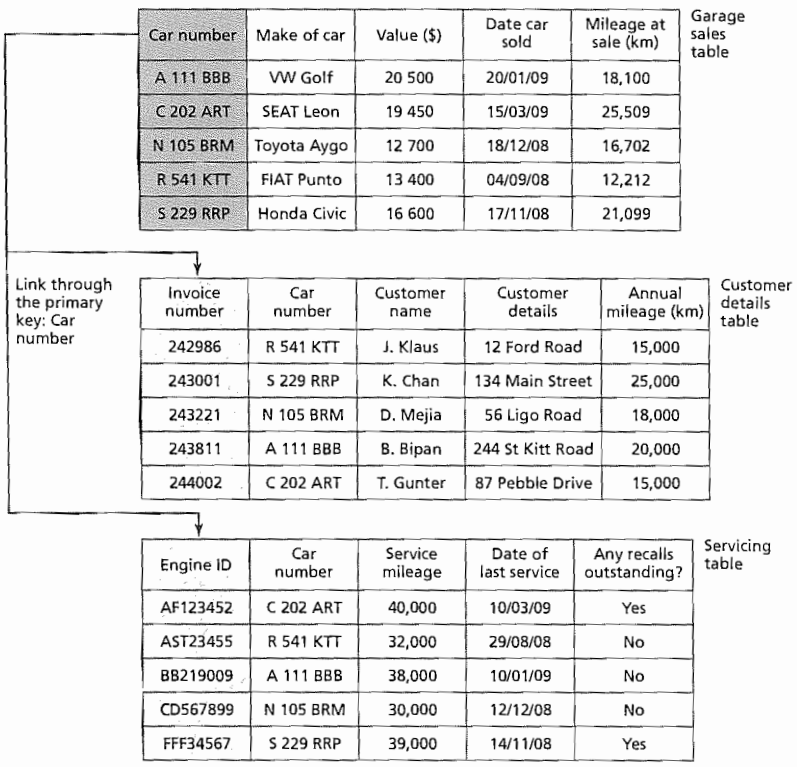
A garage sells cars and keeps a database of sales, customers and servicing, as shown in Figure 5.4 overleaf.

The primary (key) field is Car number and the column is shaded red).

The foreign key fields are Invoice number and Engine ID and these are shaded green.

Information from all three tables is linked together so, for example, if a car service was due then by typing in Car number the customer's details and servicing details are brought up on the screen. This means information can be sent to the customer as a reminder. Once the service is carried out, the servicing table will be updated which means all other references to it will also be up to date.

To help you understand these complex structures, go through the following exercise, which contains a flat data structure and a relational database.



Garage sales table

Car number	Make of car	Value ($)	Date car sold	Mileage at sale (km)
A 111 BBB	VW Golf	20 500	20/01/09	18,100
C 202 ART	SEAT Leon	19 450	15/03/09	25,509
N 105 BRM	Toyota Aygo	12 700	18/12/08	16,702
R 541 KTT	FIAT Punto	13 400	04/09/08	12,212
S 229 RRP	Honda Civic	16 600	17/11/08	21,099

Link through the primary key: Car number

Customer details table

Invoice number	Car number	Customer name	Customer details	Annual mileage (km)
242986	R 541 KTT	J. Klaus	12 Ford Road	15,000
243001	S 229 RRP	K. Chan	134 Main Street	25,000
243221	N 105 BRM	D. Mejia	56 Ligo Road	18,000
243811	A 111 BBB	B. Bipan	244 St Kitt Road	20,000
244002	C 202 ART	T. Gunter	87 Pebble Drive	15,000

Servicing table

Engine ID	Car number	Service mileage	Date of last service	Any recalls outstanding?
AF123452	C 202 ART	40,000	10/03/09	Yes
AST23455	R 541 KTT	32,000	29/08/08	No
BB219009	A 111 BBB	38,000	10/01/09	No
CD567899	N 105 BRM	30,000	12/12/08	No
FFF34567	S 229 RRP	39,000	14/11/08	Yes

Figure 5.4 Three related tables in a relational database for a garage

Exercise 5a

Example 1

Table 5.6 shows a flat data structure.

Employee number	Name of employee	Date joined	Salary ($)	Department	Telephone number
A6121	Mr J. Bloggs	30/01/2000	18,000	Sales	151 216 009
B4142	Ms N. Kahn	19/02/2001	25,000	Accounts	153 423 111
B5041	Ms R. Spacek	04/11/2001	19,000	Sales	155 119 110
A3046	Mr K. Silva	15/12/2003	40,000	Legal	148 222 333
A5211	Mr N. Choudry	01/07/2004	25,000	Accounts	130 115 100

Table 5.6 Flat file structure for data on employees in a company

a How many records are there in this section of the database?
b How many fields are there in each record?
c Which field contains:
  i numeric data only
  ii text data only
  iii alphanumeric data only?
d What field is the primary key?
e In which field has the database been sorted?
f If the database was sorted in descending order on salary, using the Employee Number only, what would be the new order of data in the sorted database?

Example 2
The database shown in Table 5.7 contains two linked tables. The database is being used to keep a record of which customers have borrowed CDs from the music lending library.

CD stock table

Barcode	CD title	CD Artist	Year released	Number of tracks
77779287727	Seasons End	Marillion	1989	10
99969313424	Kingdom of Rust	Doves	2009	9
24354273506	Let It Go	Nada Surf	2002	11
94639624829	Our Love to Admire	Interpol	2007	9
02498669105	The Invitation	Thirteen Senses	2004	12
45099625627	Seal	Seal	1994	10

Table 5.7 Tables of data relating to CDs borrowed from a library

Customer borrowing table

Customer number	Customer name	Telephone number	CD borrowed	Date due back
M10411	Mr K. Sahz	415 003 455	02498669105	15/10/2009
M21516	Mr D. Silva	841 133 222	77779287727	14/10/2009
F18113	Mr A. Adak	614 555 211	45099625627	14/10/2009
M20004	Mr R. Choudhury	416 888 210	24354273506	12/10/2009
F16117	Ms L. Smith	416 219 000	94639624829	11/10/2009
F50316	Mr M. Egodi	841 567 228	99969313424	10/10/2009

a How many records are there in the CD stock table?
b How many fields are there in each record in the Customer borrowing table?
c What type of database is being used here?
d What is the primary key in the CD stock table?
e Which field is a foreign key?
f What data type would you use in the Date due back field?
g What data types have been used in all the other fields?

5.5 Analogue and digital data

As we have already learnt from earlier chapters, computers work with **digital data**, which is defined as discrete, fixed values in a given range.

However, in the real world, physical measurements (i.e. data) are not digital but are continuously variable, producing an infinite number of values within a given range. For example, length, weight, temperature, pressure, etc. can take any value, depending on the accuracy to which they are measured. These values are measured by an **analogue device** which represents physical measurement on a continuous analogue scale, as illustrated in Figure 5.5. The speedometer represents speed by showing the position of a pointer on a dial, while the thermometer represents temperature by the height of the liquid column.

The data is known as **analogue data**. Most control and monitoring applications use devices called **sensors** to measure these physical, analogue quantities. Examples of sensors and their use in monitoring and control applications are discussed in Chapter 7.

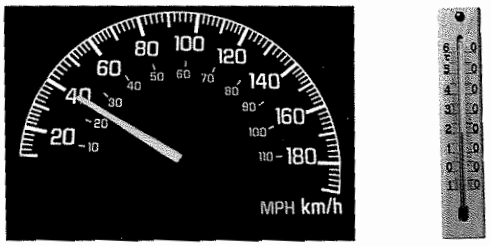


Figure 5.5 Examples of analogue devices

However, computers can only understand and manipulate digital data. Analogue data would not make any sense to the computer and may even cause some damage. To enable data in analogue form (often the input from a sensor) to be processed by a computer, it needs to be changed into a digital form. This is done using an **analogue to digital converter (ADC)**.

Alternatively, if the computer is being used to control a device, such as a motor or a valve, the device may need to be controlled by continuously variable voltages. There would be no use sending out a digital signal. It would first need to be changed into an analogue signal, requiring another device, known as a **digital to analogue converter (DAC)**.

Example of a control system

This example shows why there is a need to convert analogue to digital and also digital to analogue as part of control system involving a computer:

Figure 5.6 shows a computer being used to control a furnace heated by burning gas supplied from a gas source (the amount of gas is controlled by a valve which can have an infinite number of positions).

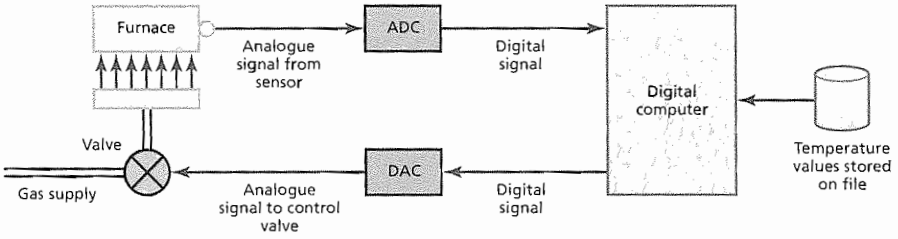


Figure 5.6 Control system for a furnace

A sensor is used to measure temperature in the furnace and it sends readings in analogue form (small electric currents/voltages). This data is converted into digital by an ADC and is fed to a computer, which compares the input temperature with the required temperature stored on a file. If any action is needed (furnace temperature is too low or too high) then a digital signal is sent out from the computer. This signal is converted into an electric current/voltage (i.e. analogue) so that the valve can be regulated (i.e. opened or closed to control the gas supply and hence the furnace temperature).

CHAPTER 6

The effects of using ICT

In this chapter you will learn about:

- software copyright rules
- viruses and hacking:
  - definitions
  - ways of protecting the system
- the effects of ICT on society:
  - employment
  - social impact
  - online shopping and banking
  - policing of the internet
  - use of microprocessors in household appliances
- information from the internet:
  - reliability of data
  - risks of undesirable websites
  - security (including phishing, pharming and spam)
- internet developments, e.g. blogs, wikis and social networking
- health and safety issues.

6.1 Introduction

The use of ICT has affected our everyday lives in many ways. These range from the effects of ICT on society in general, such as the changes in types and styles of employment, to the convenience that it offers the individual, through services such as online shopping and banking. However, in addition to providing new opportunities, ICT has introduced its own problem, such as issues relating to copyright, security of both companies and individuals, and health and safety. This chapter discusses many of these effects.

6.2 Software copyright

Software is protected by copyright laws in much the same way as music CDs, film DVDs and articles from magazines and books are protected.

When software is supplied on CD or DVD there are certain rules that must be obeyed.

- It is not legal to make a software copy and then sell it or give it away to a friend or colleague.
- Software cannot be used on a network or used in multiple computers unless a licence has been acquired to allow this to happen.
- It is not legal to use coding from the copyright software in your own software and then pass this software on or sell it as your own without the permission of the copyright holders.
- Renting out a software package without permission to do so is illegal.
- It is illegal to use the name of copyrighted software on other software without agreement to do so.

Software **piracy** (illegal copies of software) is a big issue amongst software companies. They take many steps to stop the illegal copying of software and to stop illegal copies being used once they have been sold. The following list shows a number of ways in which software is protected, both by making the installer agree to certain conditions and also by methods which require the original software to be present for it to work.

- When software is being installed, the user will be asked to key in a unique reference number (a string of letters and numbers) which was supplied with the original copy of the software.
- The user will be asked to click 'OK' or 'I agree' to the licence agreement before the software continues to install.
- The original software packaging often comes with a sticker informing the purchaser that it is illegal to make copies of the software; the label is often in the form of a **hologram**, which indicates that this is a genuine copy.
- Some software will only run if the CD-ROM or DVD-ROM is actually in the drive. This stops illegal multiple use and network use of the software.
- Some software will only run if a **dongle** is plugged into one of the USB ports (dongles were discussed in Section 3.3).

6.3 Viruses and hacking

A **virus** is a program that replicates (copies) itself and is designed to cause harm to a computer system. It often causes damage by attaching itself to files, leading to one or more of the following effects:

- causing the computer to **crash** (i.e. to stop functioning normally, lock up or stop responding to other software)
- loss of files – sometimes system files are lost which leads to a computer malfunction
- corruption of the data stored on files.

Viruses infect computers through email attachments and through illegal software or downloading of files from the internet that are infected. The following list shows ways of protecting systems against viruses.

- Use up-to-date **anti-virus** software. This detects viruses and then removes or quarantines (i.e. isolates) any file/attachment which has been infected.
- Do not allow illegal software to be loaded onto a computer and do not use any CD/DVD in the computer which comes from an unknown source.
- Only download software and files from the internet if they are from a reputable site.
- Use **firewalls** (discussed below) on networks to protect against viruses.

Note that backing up files on a regular basis does not necessarily guarantee the prevention of viruses spreading. If a file is already infected and it is then backed up, when the file is re-loaded into the 'cleaned' computer the virus may actually be re-installed!

Hacking is the act of gaining access to a computer system or network without legal authorisation. Although some **hackers** do this as a form of intellectual challenge, many do it with the sole intention of causing harm (e.g. editing/deleting files, installing harmful software, executing files in a user's directory or even committing fraud).

Some large companies actually employ hackers to test out their security systems. Although the only foolproof way of stopping a networked computer from being hacked into is to disconnect it from the internet, this is clearly not a practical or

desirable solution. Similarly, the only certain way to prevent a stand-alone computer from being hacked into is to keep it in a locked room when not in use; again, this is not always practical.

However, there are a number of ways to minimise the risk of hacking:

- use of **firewalls**: these are used on networked computers. They provide a detailed log of incoming and outgoing traffic and can control this traffic. They are able to stop malicious traffic getting to a user's computer and can also prevent a computer connecting to unwanted sites and from sending personal data to other computers and sites without authorisation
- use of **robust passwords** (i.e. difficult passwords to guess) and **user IDs** to prevent illegal access to a computer or internet site.

Whilst **encryption** makes files unreadable if accessed illegally, it does not *prevent* illegal access (hacking) in the first place. It therefore would not prevent a hacker carrying out many of the harmful actions described in this section.

6.4 Effects of ICT on society

One moral issue that has emerged from the development of ICT is the **social divide** created by computer technology and ICT. This is often referred to as the **'haves and have-nots'** – those people who have the necessary ICT skills or money to purchase and use computer equipment will gain benefit from the new technology; those who are not able to access this new technology are left even further behind leading to this social divide.

ICT has affected many aspects of society. This section is going to look at just a few of these:

- the impact on employment
- the development of online shopping and banking
- policing of the internet
- the use of microprocessors in household appliances.

Impact on employment

The introduction of ICT has led to unemployment in many areas such as:

- manufacturing, where robots have taken over many tasks (e.g. paint spraying in a car factory)
- computer-controlled warehouses, which are automatic and require no personnel to be present
- labour-intensive work (e.g. in the printing industry, checking football pools, filing, etc.).

However, it is also true that some new jobs have been created with the introduction of ICT. These include writing software, maintenance of robots and other ICT equipment and work connected with internet sites (setting sites up, maintaining them, etc.).

The overall work- related effects on people can be summarised as follows:

- the need to be re-trained because of the introduction of new technology, e.g. how to operate or maintain the new machinery which is being introduced to do the work previously done by a person
- a cleaner working environment where robots have taken over many of the 'dirty' manual tasks

- de-skilling of the workforce, as jobs where high skills were needed in the past are now done by computer systems (e.g. the use of DTP software in the printing industry, CAD software in producing engineering drawings, etc.)
- a safer working environment (e.g. fewer people working in noisy factories)
- fewer manual tasks, since tasks such as heavy lifting are now done by robots.

Companies have also gained from the introduction of ICT systems. For example:

- there is no need to employ as many people to do the tasks, thus reducing labour costs
- robots do not take holidays, get sick or take coffee breaks, resulting in higher productivity
- whilst the quality is not necessarily better, there is greater consistency in the products made (e.g. every car coming off a production line will be identical).

Impact of using ICT for online shopping and banking

The development of online shopping and banking has led to changes in the type of employment in shops and banks. Fewer staff are now needed in traditional shops and banks, but new staff are needed to provide the online services (e.g. packing and sending out orders, courier services, and so on). As the amount of **online shopping** and **banking** increases, the impact on society begins to gain in significance. (The applications are covered in more depth in Chapter 7; this section will deal primarily with the impact of ICT.)

Online shopping and banking means that more and more people are staying at home to buy goods and services, manage their bank accounts and book holidays, etc. This would all be done using a computer connected to the internet and some form of electronic payment (usually a credit or debit card). The following notes give a comprehensive list of the benefits and drawbacks of using the internet to carry out many of these tasks.

Advantages

- There is no longer a need to travel into the town centre thus reducing costs (money for fuel, bus fares, etc.) and time spent shopping. It also helps to reduce town centre congestion and pollution.
- Users now have access to a worldwide market and can thus look for products that are cheaper. This is less expensive and less time consuming than having to shop around by the more conventional methods. They also have access to a much wider choice of goods.
- Disabled and elderly people can now get access to shops and banks without the need to leave home. This helps to keep them part of society since they can now do all the things taken for granted by able-bodied people.
- Because it is online, shopping and banking can be done at any time on any day of the week – this is termed 24/7. This is particularly helpful to people who work, since shops/banks would normally be closed when they finished work.
- People can spend more time doing other things. For example, going shopping to the supermarket probably took up a lot of time; by doing this online people are now free to do more leisure activities, for example.

Disadvantages

- There is the possibility of isolation and lack of socialisation if people stay at home to do all their shopping and banking.
- There are possible health risks associated with online shopping and banking (discussed in Section 6.7).
- Security issues (e.g.) are a major concern. These include:
  - hacking, stealing credit card details, etc. (discussed in Section 6.3)
  - viruses and other malware (e.g. phishing, pharming, etc., discussed in Section 6.5)
  - fraudulent websites (discussed in Section 6.5).
- It is necessary to have a computer and to pay for line rental to take part in online shopping and banking. Also the telephone line will be tied up if the user does not have a broadband connection.
- Unlike high street shopping, it is not possible to see (or try on) the goods first before buying them. The goods also take several days to arrive.
- There is a risk of lack of exercise if people do all their shopping and banking at the computer.
- High street shops and banks are closing because of the increase in online shopping and banking and this is leading to 'ghost towns' forming.

Effects on companies due to the spread of online shopping and banking

The discussion above focused on the effects of ICT on people. However, companies and other organisations have also been affected by the growth of ICT and online shopping and banking.

- Companies can save costs since fewer staff are required and they do not need as many shops and banks in high streets to deal with potential customers.
- Because the internet is global, the potential customer base is increased.
- There will be some new costs, however, because of the need to re-train staff and the need to employ more staff in despatch departments.
- There are also costs due to the setting up and maintaining of websites to enable online shopping and banking.
- Since there is very little or no customer-employee interaction, this could lead to a drop in customer loyalty, which could result in loss of customers. This could also be brought about by the lack of personal service associated with online shopping and banking.

Should the internet be policed?

This is a question which has raged for many years. Currently, the internet has no controlling body to ensure that it conforms to certain standards. There are many arguments in favour of control and as many arguments against.

Arguments in favour of some form of control

- It would prevent illegal material being posted on websites (e.g. racist/prejudiced material, pornographic matter, material promoting terrorist activities, etc.).
- People find it much easier to discover information which can have serious consequences (e.g. how to be a hacker, how to make bombs, etc.). Although most of this can be found in books, it is much easier to find the information using a search engine.

- It would prevent children and other vulnerable groups being subjected to undesirable websites.
- Since anyone can produce a website, there is no guarantee of the accuracy of information. Some form of control could reduce the amount of incorrect information being published.

Arguments against some form of control

- Material published on the websites is already available from other sources.
- It would be very expensive to 'police' all websites and users would have to pick up the bill.
- It would be difficult to enforce rules and regulations on a global scale.
- It can be argued that policing would go against freedom of information.
- Many topics and comments posted on websites are already illegal and laws currently exist to deal with the perpetrators.

Microprocessor-controlled devices in the home

Many common household devices are now fitted with microprocessors to control a large number of their functions. The devices fall into two categories:

- **labour-saving devices**, which include automatic washing machines, microwave ovens, ovens, and dishwashers
- other household devices, such as television sets, hifis, fridge/freezers and central heating systems – these are not labour saving, but they do have microprocessors to control many of their functions.

Tables 6.1 and 6.2 give the advantages and disadvantages of both types of devices.

Advantages	Disadvantages
• They lead to more leisure time since the devices can be programmed to do the tasks. • People have more time to go out and socialise, and can go out when they want to. • They are becoming very sophisticated and can make use of embedded web technology.	• They can lead to unhealthy diets (e.g. TV dinners). • People can tend to become lazy, since they rely on these devices.

Table 6.1 Advantages and disadvantages of microprocessor-controlled labour-saving devices

Advantages	Disadvantages
• They save energy, since they can switch off automatically. • It is easier to program the devices to do a task rather than having to set timings, dates, etc. manually.	• They lead to a more wasteful society: devices are thrown away if the electronics fail, since they are not economic to repair. • They can be more complex to operate for people who are not technology literate. • Leaving devices on standby (such as televisions) leads to a waste of resources.

Table 6.2 Advantages and disadvantages of other microprocessor-controlled devices

6.5 Information from the internet

The social and general impact of using the internet or devices which rely on microprocessors have been discussed in earlier sections. This section will now look at the *quality* of information found on the internet when using a **search engines**. There are four main aspects to consider:

- reliability of information
- undesirability of certain websites
- security issues
- other internet issues.

Reliability of information

- Information is more likely to be up to date than in books, since websites can be updated very quickly.
- It is much easier to get information from websites, as search engines quickly link key words together and find information that matches the criteria.
- There is a vast amount of information on the internet, which is easier to locate than using the indices in several books.
- However, information on the internet may be incorrect, inaccurate or even biased since it does not go through any checking process.
- There is a risk of information overload even if search engines are used properly. It is possible to get thousands of **hits**, which may make it difficult to find the information relevant to the user's search.

Undesirability of certain websites

- There is always the risk of finding undesirable websites (as discussed in Section 6.4).
- There is also a risk of doubtful websites which are not genuine and could lead to a number of problems such as undesirable web links, security risks, etc.
- Security risks are a very large problem and are discussed in the following section.

Security issues

The risk of viruses and hacking has already been discussed in Section 6.3. The use of passwords, user IDs, encryption, firewalls and other software protection was also discussed in Section 6.3. However, there are other security risks (not necessarily as a result of viruses or hacking) associated with connecting to the internet. These security risks are now discussed in some depth.

Phishing

Phishing is a fraudulent operation involving the use of emails. The creator sends out a legitimate-looking email, hoping to gather personal and financial information from the recipient of the email. To make it more realistic (and therefore even more dangerous!) the message will appear to have come from some legitimate source (such as a famous bank). As soon as an unsuspecting user clicks on the link they are sent to a spoof website where they will be asked for personal information including credit card details, PINs, etc. which could lead to **identity theft**.

Many ISPs now attempt to filter out phishing emails, but users should always be aware that a risk still exists and should be suspicious of any emails requesting unsolicited personal details.

Pharming

Pharming is a **scam** in which malicious code is installed on a computer hard disk or a server. This code has the ability to misdirect users to fraudulent websites, usually without their knowledge or consent.

Whereas phishing requires an email to be sent out to *every* person who has been targeted, pharming does not require emails to be sent out to everybody and can therefore target a much larger group of people much more easily. Also, no conscious action needs to necessarily be made by the user (such as opening an email), which means the user will probably have no idea at all that have been targeted. Basically, pharming works like this:

A hacker/pharmer will first infect the user's computer with a virus, either by sending an email or by installing software on their computer when they first visit their website. It could also be installed as part of something the user chooses to install from a website (so the user doesn't necessarily have to open an email to become infected). Once infected, the virus would send the user to a fake website that looks almost identical to the one they really wanted to visit. Consequently, personal information from the user's computer can picked up by the pharmer/hacker.

Certain **anti-spyware**, anti-virus software or anti-pharming software can be used to identify this code and correct the corruption.

Spam

Spam is electronic **junk mail** and is a type of advertising from a company sent out to a target **mailing list**. It is usually harmless but it can clog up the networks, slowing them down, or fill up a user's mail box. It is therefore more of a nuisance than a security risk.

Many ISPs are good at filtering out spam. In fact, some are so efficient that it is often necessary to put legitimate email addresses into a contacts list/address book to ensure that *wanted* emails are not filtered out by mistake.

Spyware

Spyware is software that gathers user information through their network connections without them being aware that this is happening. Once spyware is installed, it monitors all key presses and transmits the information back to the person who sent out the spyware. This software also has the ability to install other spyware software, read **cookies** and even change the default home page or web browser. Anti-spyware can be used to search out this software and correct the corruption.

Other internet issues

Although the following item is not regarded as a security threat, it can be a considerable nuisance to an internet user and is included here for completeness.

Cookies

Cookies are small files sent to a user's computer via their web browser when they visit certain websites. They store information about the users and this data is accessed each time they visit the website. For example:

- they remember who the user is and send messages such as 'Welcome Daniel' each time they log onto the website
- they recognise a user's buying preferences; e.g. if a user buys CDs, **pop ups** (adverts) related to their buying habits will appear on the user's screen each time they visit the website.

Without cookies, the web server would have no way of knowing that the user had visited the website before.

6.6 Internet developments

The internet has changed out of all recognition since it first started, and continues to develop. This section considers some of the most recent developments in the way the internet is used.

Web 2.0 refers to a second generation of internet development and design. This has led to a development of new web-based communication, applications and **hosted servers**. For example, the following will be considered in more detail in this section:

- blogs
- wikis
- digital media sharing websites
- social networking sites
- folksonomies.

Blogs

Blogs (which is an abbreviation for **web logs**) are personal internet journals where the writer (or **blogger**) will type in their observations on some topic (e.g. a political view) or even provide links to certain relevant websites. No training is needed to do this.

Blogs tend to range from minor projects where people just gossip about some topic (such as the performance of an actor in a recent film) through to important subjects such as politics, advertising products or raising awareness of a certain key event taking place. However, comments made are *not* immune from the law and bloggers can still be prosecuted for making offensive statements about people!

Wikis

The word 'wiki' comes from a Hawaiian word meaning 'fast'. **Wikis** are software allowing users to easily create and edit web pages using any web browser. A wiki will support hyperlinks and has very simple **syntax** (language rules) for creating pages. They have often been described as 'web pages with an edit button'. Anyone can use wikis, which means that the content should always be treated with some caution. One of the most common examples of a wiki is the online encyclopedia Wikipedia.

Digital media sharing websites

Digital media sharing websites allow users to upload video clips and other media to an internet website. The video host, for example, will then store the video on a server and show the user the different types of code which can be used to enable them to view the video clip.

This development is becoming increasingly popular since most users don't have unlimited web space. One of the most common examples of this is YouTube.

Social networking sites

Social networking sites focus on building online communities of users who share the same interests and activities. They enable young people, in particular, to share photos of themselves, show people their favourite videos and music, what they like to do in their spare time, what they like to eat, etc.

Common examples include Facebook and Myspace, where users can join free of charge and interact with other people. It is possible to add friends and post messages on a bulletin/message board and update personal profiles to notify friends about themselves.

These are rapidly becoming the modern way of interacting socially and they allow young people, in particular, to communicate across the world and share their interests and views with many people.

Folksonomies

Folksonomies are closely related to **tagging** and literally mean 'management of people'. Tagging is a type of social **bookmarking** where a user can tag any web page with words that describe its contents. Anyone can view web pages corresponding to a specific tag. In folksonomies, the visual representation is a tag cloud – this is a sequence of words of different sizes that represent popular tags by showing them in a larger font size. One of the most common examples is Flickr.

6.7 Health and safety issues

There are many health and safety problems associated with regular use of computer systems.

Health and safety regulations advise that all computer systems have a minimum of tiltable and anti-glare screens, adjustable chairs and foot supports, suitable lighting, uncluttered work stations, and recommend frequent breaks and eye tests.

Although health and safety are closely related, they are very different subjects. Health issues are related to how to stop people becoming ill or affected by daily contact with computers. Safety is more concerned with the dangers which could lead to serious injury or even loss of life. They are discussed in separate sections below to help clarify the main differences.

Health aspects

Table 6.3 highlights a number of health issues, together with possible solutions to either minimise the risk or eliminate it altogether.

Health risk	Solution
Back and neck problems/strain	• use fully adjustable chairs to give the correct posture • use foot rests to reduce posture problems • use screens that can be tilted to ensure the neck is at the correct angle
Repetitive strain injury (RSI) – damage to fingers and wrists	• ensure correct posture is maintained (i.e. correct angle of arms to the keyboard and mouse, for example) • make proper use of a wrist rest when using a mouse or a keyboard • take regular breaks and do some exercise • use ergonomic keyboards • use voice-activated software if the user is prone to problems when using mouse and keyboard
Eyestrain (caused by staring at a computer screen too long or bad lighting in the room)	• ensure that there is no screen flicker, since this can lead to eye problems • change to LCD screens where flicker is less of a problem than with CRT screens • take regular breaks and try focusing on a point which is some distance away • make use of anti-glare screens if lighting in the room is a problem or use window blinds to reduce strong sunlight • have eyes tested regularly – middle-vision glasses should be prescribed if the user has a persistent problem such as eye strain, dry eyes, headaches, etc.)
Headaches	• use an anti-glare screen or use window blinds to cut out light reflections – bad lighting can cause squinting and lead to headaches, etc. • take regular breaks and do some exercise • have eyes tested regularly and use middle-vision glasses if necessary
Ozone irritation (dry skin, respiratory problems, etc.) – this is caused by laser printers in an office area	• ensure proper ventilation to remove the ozone gas as quickly as possible • house laser printers in a designated printer room • change to other types of printer if necessary (e.g. inkjet printers)

Table 6.3 Health risks and proposed solutions

Safety aspects

Table 6.4 gives a number of safety issues, together with possible solutions to eliminate or minimise the risk.

Safety hazard	Ways of eliminating or minimising hazard
Electrocution	• use of a residual circuit breaker (RCB) • check insulation on wires regularly • do not allow drinks near computers • check equipment regularly
Trailing wires (trip hazard)	• use cable ducts to make the wires safe • cover wires and/or have them neatly tucked away (under desks, etc.) • try and use wireless connections wherever possible, thus eliminating cables altogether
Heavy equipment falling	• use strong desk and tables to support heavy hardware • use large desks and tables so that hardware isn't too close to the edge where it can fall off
Fire risk	• have a fully tested CO2/dry fire extinguisher nearby (*not* water extinguishers!) • don't cover equipment vents, which can cause equipment to overheat • make sure hardware is fully maintained • ensure good ventilation in the room, again to stop overheating of hardware • do not overload sockets with too many items • change to low voltage hardware wherever possible (e.g. replace CRT monitors with LCD monitors)

Table 6.4 Safety hazards and proposed solutions

CHAPTER 7

The ways in which ICT is used

In this chapter you will learn about:

- communication systems
- satellite and mobile phone network communications
- data handling applications
- modelling applications
- batch processing and online systems
- control and monitoring applications
- robotics
- batch processing applications
- automatic stock control systems (use of barcodes)
- online booking systems
- banking applications
- library systems
- expert systems.

7.1 Introduction

This chapter looks at how ICT is used in everyday life and discusses the many advantages and drawbacks of using computer systems to replace or enhance applications which were previously paper or manually based.

7.2 Communications applications

There are several communication applications that make use of ICT technology. These fall into two categories: methods of communication and ways of communicating information.

Methods of communication include:

- video conferencing
- voice over internet protocol (VOIP) systems
- emails.

These were discussed in Section 4.7, and so are not considered any further here.

There are a large number of ways of communicating information. The five considered here are:

- multimedia presentations
- printing flyers and posters
- use of websites
- music production
- cartoon animations.

Multimedia presentations

Presentations using animation, video and sound/music are generally much more interesting than a presentation done on slides or paper.

The presentations are produced using one of the many software packages on the market and then used with a **multimedia projector** so that the whole audience is able to see the presentation. Some of the advantages of this type of presentation include:

- the use of sound and animation/video effects
- interactive/hyperlinks built into the presentation
- the fact that it is more likely to hold the audience's attention.

Some of the disadvantages include:

- the need to have special equipment, which can be expensive
- sometimes the requirement for internet access within the presentation, if the user wishes to access files (e.g. music or video) from websites or up-to-date information (e.g. weather reports) which needs a live connection.

Paper-based presentations

It is always possible to produce presentations in a hardcopy format rather than the system described above. This has the following advantages:

- Disabled people do not have to go to the venue to see the presentation.
- It is possible to print it out in Braille for the benefit of blind people.
- The recipient can read the presentation at any time they want.
- The recipients have a permanent copy, which they can refer to at any time they want.

There are, however, disadvantages:

- The presentation needs to be distributed in some way.
- There are no special effects (sound, video, animation).
- There are printing costs (paper, ink, etc.).

Flyers and posters

Flyers and posters can be produced very easily using one of the many software packages available, most commonly **word processors** and **desktop publishers** (DTP). Usually, the flyer or poster will have photos which have been taken specially or have been downloaded from the internet. The following sequence is fairly typical of how such a document would be produced on a computer system:

- A word processor or DTP application is opened.
- The user creates frames, boxes and text boxes.
- If necessary, photos are taken, using a camera.
- The images are uploaded from the camera, loaded from a CD/DVD, scanned from hard-copy photos or downloaded from the internet.
- The photos are saved to a file.
- The photos are imported or copied and pasted into the document.
- The photos are edited and text typed in or imported from a file and then put into the required style.

Websites

Rather than producing flyers and posters by printing them out, it is possible to use websites for advertising and communication. There are a number of advantages and disadvantages of using this technique.

Advantages include:
- the ability to add sound/video/animation
- links to other websites/**hyperlinks**
- the use of **hot spots**
- buttons to navigate/move around the website
- hit counters to see who has visited the websites.

Disadvantages include:
- the fact that websites can be hacked into and modified or viruses introduced
- the need for a computer and internet connection
- its lack of portability compared with a paper-based system
- the need to maintain the website once it is set up.

Music production

The generation of music and the production of music scores can now be done by computer systems with the appropriate software, for example:
- music samplers and mixers allow the original tracks that were recorded in the studio to be modified in any way that the producer wants
- electronic instruments (like guitars and organs) can play back through electronic effects machines
- synthesisers combine simple wave forms to produce complex music creations
- electronic organs can mimic any other instrument
- music scores can be generated from the music itself using software
- software can automatically correct music notes in a score
- there is no need to understand music notation to write a music score
- music notes are automatically printed out in the correct format.

Cartoon animations

Animation can be produced using computer hardware and software. With **3D animation**, objects are designed on a computer and a 3D skeleton produced. The parts of the skeleton are moved by the animator using key frames (these frames define the start point and end point to give a smooth animation effect). The difference in the appearance of the skeleton in these key frames is automatically calculated by the software and is known as **tweening** or **morphing**. The final stage is to make a realistic image by a technique known as **rendering**.

7.3 Satellite and mobile network communications

This section considers three applications which make use of satellite technology and/or mobile phone network technology:
- mobile phone networks
- embedded web technology (EWT)
- global positioning satellite systems (GPS).

Mobile phone networks

Mobile phones communicate by using towers inside many cells networked together to cover large areas, illustrated in Figure 7.1. The towers allow the transmission of data throughout the mobile phone network.

Each tower transmits within its own cell. If you are driving a car and get to the edge of a cell the mobile phone signal starts to weaken. This is recognised by the network and the mobile phone then picks up the signal in one of the adjacent cells. If a person is making a call or sending a text to somebody in a different country then satellite technology is used to enable the communication to take place.

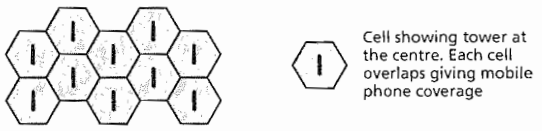


Figure 7.1 A network of mobile phone cells

Mobile phone technology can now be used by computers. A plug-in device (using one of the available USB ports) allows the computer to connect to the mobile phone network, which then allows access to the internet. This service is usually provided through a monthly contract which gives a download limit.

Embedded web technology

Embedded web technology (EWT) is a relatively new development that uses the internet in real time to control or interact with a device in the home or a device which is part of an industrial application. The device must contain an **embedded microprocessor** for this system to work.

The device can be controlled by an authorised user from a computer anywhere on a network or from a **web-enabled mobile phone**.

Consider the scenario of an oven equipped with an embedded processor. An authorised person can use their web-enabled mobile phone, for example, to send instructions to control the oven remotely (e.g. switch it on at a given time, set the timings and set the temperature) from their office before setting off for home. Any device with an embedded microprocessor can be controlled in this way; examples include a DVD recorder, a washing machine, a central heating system or even a scientific experiment in some remote location (e.g. in outer space or under the sea).

Global positioning satellite (GPS) systems

Global positioning satellite (GPS) systems are used to determine the exact location of a number of modes of transport (e.g. airplanes, cars, ships, etc.). Cars usually refer to GPS as **satellite navigation systems** (sat navs).

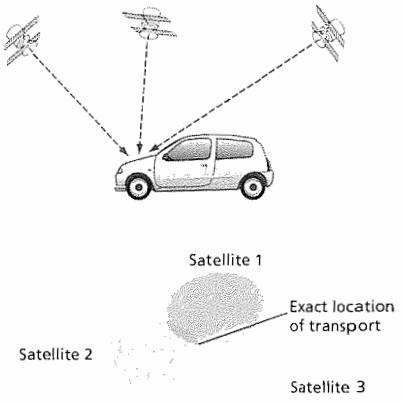


Figure 7.2 Calculation of position using satellites

Satellites surrounding the Earth transmit signals to the surface. Computers installed in the mode of transport receive and interpret these signals. Knowing their position on the Earth depends on very accurate timing – atomic clocks are used in the satellites which are accurate to within a fraction of a second per day. Each satellite transmits data indicating its position and time. The computer on board the mode of transport calculates its exact position based on the information from at least three satellites, illustrated in Figure 7.2.

In cars, the on-board computer contains pre-stored road maps. With these sat nav systems the car's exact location, based on satellite positioning, can be shown on the map and the driver can also be given verbal instructions such as: 'After 100 metres,

take the next left turn onto the A1234'. A screen on the sat nav device will also show the car's position in relation to the road network (see Figure 7.3).

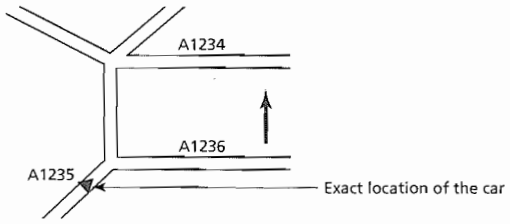


Figure 7.3 Car position shown on a sat nav screen

Advantages

- The driver does not have to consult paper maps while driving, so it is far safer.
- It removes errors, as it can warn drivers about one way streets, street closures, etc.
- The system can warn the driver about the location of speed cameras, again aiding safety.
- The system can estimate the time of arrival.
- It is also possible to program in the fastest route, a route to avoid towns, etc.
- The system can give useful information such as the location of petrol stations.

Disadvantages

- If the maps are not kept up to date, they can give incorrect instructions.
- Unless the system is sophisticated, road closures, due to accidents or road works, can cause problems.
- Loss of satellite signals can cause problems.
- If an incorrect start point or end point is keyed in, the system will give incorrect information.

7.4 Data handling applications

A number of applications make use of simple data handling techniques, such as:

- surveys
- tuck shop (i.e. school sweet shop) records
- clubs and society records
- record keeping (e.g. a book shop).

Surveys

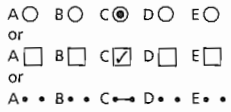


Figure 7.4 Methods of filling in questionnaires

Suppose a small business is interested in finding out information about the buying habits of a number of customers. Questionnaires or surveys will be either handed out to people or posted on a website to allow them to be filled in online. Paper questionnaires will be filled in either by shading in circles, ticking in boxes or connecting two points to select the correct response (see Figure 7.4).

Online questionnaires would tend to use the first option (using **radio buttons**) since this is a quick and easy method for gathering data.

Paper surveys are then scanned in using **optical mark recognition (OMR)** or **optical character recognition (OCR)** methods and the information is transferred to a database. The advantages of doing this rather than checking each one by hand are that:

- it is faster to get results
- there are fewer errors
- it is easier to do a statistical analysis
- it is less expensive to carry out, since it needs fewer people.

Online questionnaires have the added advantage that no data preparation is needed, as the results are sent directly to a database for analysis.

Tuck shop records

An example of the use of **spreadsheets** to keep school tuck shop accounts is given in Section 7.5. Simple financial applications such as these use spreadsheets to keep a record of prices and takings. The advantage is that it is much easier to vary different parameters to show how to optimise profits or to see why a loss is being made. The system can be programmed (using macros) to automatically warn of any problems.

Club and society records

Clubs and societies need to keep records of their membership. The information held typically includes payment details, contact details (phone number, address), interests, etc. A simple database is often used to hold all this information, making it unnecessary to keep paper records. Consequently, if a particular item of interest (e.g. a talk on F1 motor racing) comes up then the computer system can quickly scan all the records on file and find out who would be interested in this topic. The organisation can then automatically contact the member by email or, using **mail merging**, send out a letter and flyer.

It is also easy to check on membership subscriptions and send out reminders. This all saves having manual records on paper, which take time to search, can be easily lost, can have some details missing. It is also less expensive (cost of paper, filing, etc.) and saves on space in the office area.

It is worth noting that data stored by the club/society may be of a personal nature and must therefore obey the rules of a data protection act.

A typical data protection act

The purpose of a data protection act is to protect the rights of the individual about whom data is obtained, stored and processed (i.e. collection, use, disclosure, destruction and holding of data). Any such act applies to both computerised and paper records.

Any data protection act is based on eight simple principles:

1 Data must be fairly and lawfully processed.

2 Data can only be processed for the stated purpose.

3 Data must be adequate, relevant and not excessive.

4 Data must be accurate.

5 Data must not be kept longer than necessary.

6 Data must be processed in accordance with the data subject's rights.

7 Data must be kept secure.

8 Data must not be transferred to another country unless they too have adequate protection.

Failure to abide by these simple rules can lead to a fine and/or imprisonment to anyone who holds data about individuals.

There are general guidelines about how to stop data being obtained unlawfully:

- Don't leave personal information lying around on a desk when not being used.
- Lock all filing cabinets at the end of the day or when an office is unmanned for any length of time.
- Do not leave data on a monitor if unattended or log off from a computer system if it is to be unattended for a time.

- Protect passwords and don't give them out to anybody else.
- Change passwords regularly and select passwords which are difficult to 'crack'.
- Make sure anything in a fax/email is not of a sensitive nature (ask yourself the question: 'Would I write that on a post card?')

All of the above are in addition to the number of safeguards discussed throughout this book (such as ways to prevent hacking, phishing, pharming, etc.).

Record keeping

To evaluate the advantages of using a computer system for record keeping, we will consider the case of a small bookshop. This shop keeps files on the books in stock and on their customer base. Using a simple database it would be easy to keep this information in electronic form. This would make it easy to contact customers if a particular book was just published or to check on their buying habits. If a customer came into the shop it would also be far easier to search for a particular book (based on title, author or ISBN). No paper records would need to be kept which would lead to the following advantages to the shop:

- Less room would used up in the shop since no paper record would need to be kept.
- It would be quicker and easier to find details of a particular book or find out whether or not it was in stock.
- The system would be less expensive, since it wouldn't be necessary to employ somebody to do all the filing and searching.
- There would be fewer errors since no manual checking of paper files would be done.

There are some disadvantages of the system:

- The shop would need to buy a computer and software to run the system.
- It would take a lot of time and effort to transfer all the paper files to the database.

7.5 Modelling applications

A **simulation** is the creation of a **model** of a real system in order to study the behaviour of the system. The model is computer generated and is based on mathematical representations.

The idea is to try and find out what mechanisms control how a system behaves and consequently predict the behaviour of the system in the future and also see if it is possible to influence this future behaviour.

Computer models have the advantage that they save money, can help find a solution more quickly and can be considerably safer (discussed further below). There are many examples of simulations, ranging from simple spreadsheet representations through to complex flight simulators. This section gives two examples: a model for showing a shop's profit/loss and a traffic light simulation.

Tuck shop model

This example uses a spreadsheet to do the modelling. It models the school tuck shop mentioned in Section 7.4. The numbers in the spreadsheet model are shown in Figure 7.5, with Figure 7.6 showing the formulae that produce these numbers.

	A	B	C	D	E	F	G
1	Item name	Price each ($)	Selling price ($)	Profit per item	Weekly shop cost ($)	Number sold	Total profit per item ($)
2							
3							
4	chew	1.00	1.50	0.50	200.00	35	17.50
5	chox	2.00	2.50	0.50	200.00	45	22.50
6	gum	3.00	3.50	0.50	200.00	30	15.00
7	crisps	1.00	1.50	0.50	200.00	45	22.50
8	cake	2.00	2.50	0.50	200.00	40	20.00
9							
10					200.00	Profit/Loss ($)	-102.50

Figure 7.5 Results in the spreadsheet model for a tuck shop

	A	B	C	D	E	F	G
1	Item name	Price each ($)	Selling price ($)	Profit per item	Weekly shop cost	Number sold	Total profit per item ($)
2							
3							
4	chew	1	1.5	=(C4-B4)	200	35	=(D4*F4)
5	chox	2	2.5	=(C5-B5)	200	45	=(D5*F5)
6	gum	3	3.5	=(C6-B6)	200	30	=(D6*F6)
7	crisps	1	1.5	=(C7-B7)	200	45	=(D7*F7)
8	cake	2	2.5	=(C8-B8)	200	40	=(D8*F8)
9							
10					200	Profit/Loss ($)	=SUM(G4:G8)-E10

Figure 7.6 Expressions in the spreadsheet model for a tuck shop

Thus, by varying the values in column C or in column F it would be possible to model the shop's profit or loss. This is a very simple model but it shows the principal of using spreadsheets to carry out any type of modelling that can be represented in a mathematical form.

Traffic light simulation

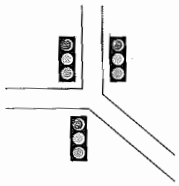


Figure 7.7 A junction controlled by traffic lights

To demonstrate a more complex simulation, the following scenario has been chosen: a set of traffic lights are to be modelled at a Y-junction, as shown in Figure 7.7.

In this simulation it is necessary to consider:

- how and what data needs to be collected
- how the simulation is carried out
- how the system would work in real life.

Data collection

Since the success (or failure) of a simulation model depends on how realistic it is, data needs to be collected by watching traffic for a long period of time at the Y-junction. This is best done by using induction loop sensors which count the number of vehicles at each junction. Manual data collection is possible but is prone to errors and is difficult to do over an 18-hour period per day, for example. The following data is an indication of what would need to be collected:

- the number of vehicles passing the junction in all directions
- the time of day for the vehicle count
- how many vehicles build up at the junction at different times of the day
- how vehicle movements change at weekends, bank holidays, etc.
- how long it takes a vehicle to clear the junction
- how long it takes the slowest vehicle to pass through the junction
- the movements made by vehicles (e.g. left turns, right turns, filtering, etc.)
- additional environmental factors, such as whether there are pedestrian crossings nearby.

Carrying out the simulation

Data from the above list is entered into the computer and the simulation run. The results of the simulation are compared with actual traffic flow from a number of data sets. Once the designers are satisfied that it simulates the real situation accurately, then different scenarios can be tried out. For example:

- vary the timing of the lights and see how the traffic flow is affected
- build up the number of vehicles stopped at part of the junction and then change the timing of the lights to see how the traffic flow is affected
- increase or decrease traffic flow in all directions
- how emergency vehicles affect traffic flow at different times of the day.

Using the simulation

This simulation can then be used to optimise the flow of traffic through the junction on an ongoing basis.

- Sensors in the road gather data and count the number of vehicles at the junction.
- This data is sent to a control box or to a computer. It may need to be converted first into a form understood by the computer.
- The gathered data is compared to data stored in the system. The stored data is based on model/simulation predictions which were used to optimise the traffic flow.
- The control box or computer 'decides' what action needs to be taken.
- Signals are sent out to the traffic lights to change their timing if necessary.

Why simulations are used

- They are less expensive than having to build the real thing (e.g. a bridge).
- On many occasions it is safer to run a simulation – some real situations are hazardous (e.g. chemical processes).
- With simulations, various scenarios can be tried out in advance.
- It is nearly impossible to try out some tasks in real life because of the high risk involved or the remoteness (e.g. in outer space, under the sea, in nuclear reactors, crash testing cars, etc.).
- It is often faster to do a simulation than the real thing. Some applications could take years before a result was known (e.g. climate change calculations, population growth, etc.).

There are some limitations to using simulations:

- They are only as good as the data used and the mathematical algorithms representing the real-life situations. They therefore have a limited use in some very complex applications (e.g. simulating a nuclear process).
- They can be very expensive to set up and often require specialist software to be written.
- They frequently require very fast processors/computer systems (which can be expensive) to do the necessary 'number crunching'; many simulations are made up of complex mathematical functions and use several thousand data sets.

Exercise 7a

Here is a list of five simulations/models and a list of five reasons why models are carried out. Try and match the five simulations to the *best* reason why that simulation would be done.

Simulation	Reason
Pilot training	Cost of building the real thing is too expensive
Environmental modelling	Some situations are too dangerous to humans
Simulating bridge loading	Take too long to get results back from real thing
Nuclear reactor model	It is almost impossible to do the tasks for real
Space exploration	Easier/safer to make changes to a model

7.6 Types of processing

There are three basic types of processing:

- batch processing
- real-time (transaction) or online processing
- real-time process control.

Batch processing

With **batch processing**, a number of tasks (**jobs**) are all collected together over a set period of time. The jobs are then loaded into a computer system (known as a **job queue**) and processed all at once (in a **batch**). Once the batch processing starts, no user interaction is needed. This type of processing can only be done where there are no timing constraints, i.e. files don't need to be updated immediately or a response from the computer is not needed straight away.

A big advantage of batch processing is that the jobs can be processed when the computer system is less busy (e.g. overnight), so the use of resources is being optimised. Areas where batch processing is used include billing systems (e.g. electricity, gas, water and telephone), payroll systems and processing of bank cheques. Section 7.9 considers batch processing applications in more detail.

Real-time (transaction) processing

Real-time (transaction) processing is an example of **online processing**. When booking seats on a flight or at the theatre, for example, this type of online processing is required. The response to a query needs to be very fast in order to prevent 'double booking' and seats need to be marked as 'unavailable' immediately the booking is confirmed. (Booking applications are covered in more detail in Section 7.11.)

Examples of the use of this type of processing include flight bookings, cinema and theatre bookings and use of an **automatic teller machine** (**ATM**) when getting money.

Real-time process control

Although this is still an example of **online processing**, it is very different to real-time (transaction) processing. This system usually involves sensors and feedback loops (e.g. monitoring and control applications – these are covered in more detail in Section 7.7).

In real-time (transaction) processing, files are updated in real time (e.g. booking flights) but in real-time process control, physical quantities (such as a temperature) are continually monitored and the input is processed sufficiently quickly to influence the input source.

7.7 Control applications

This section is split into two parts: turtle graphics and the use of sensors to control or monitor applications.

Turtle graphics

This is based on the computer language called LOGO and is now usually known as **turtle graphics**. It is essentially the control of the movement of a 'turtle' on a computer screen by a number of key instructions which can be typed in. The most common commands are given in Table 7.1. Thus, to draw the shape shown in bold in Figure 7.8, the instructions listed in Table 7.2 need to be carried out. Note that there are two possible sequences of instructions, which will both draw the same shape – the second option makes use of 'Repeat' instructions and so is more efficient in its coding.

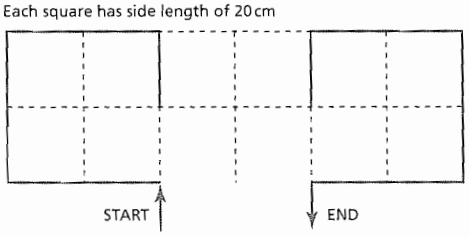


Figure 7.8 Shape to be drawn by the turtle

Command	Meaning
FORWARD *x*	Move *x* cm forward
BACKWARD *x*	Move *x* cm backward
LEFT *d*	Turn left through *d* degrees
RIGHT *d*	Turn right through *d* degrees
REPEAT *n*	Repeat next set of instructions *n* times
ENDREPEAT	Finish the repeat loop
PENUP	Lift the pen up
PENDOWN	Lower the pen

Table 7.1 Common turtle graphics commands

Option 1 instructions		Option 2 instructions	
Pendown	Forward 40	Pendown	Pendown
Left 90	Left 90	Left 90	Forward 20
Forward 40	Pendown	Repeat 3	Repeat 3
Right 90	Forward 20	Forward 40	Right 90
Forward 40	Right 90	Right 90	Forward 40
Right 90	Forward 40	Endrepeat	Endrepeat
Forward 40	Right 90	Forward 20	
Right 90	Forward 40	Penup	
Forward 20	Right 90	Left 90	
Penup	Forward 40	Forward 40	
Left 90		Left 90	

Table 7.2 Instructions to draw the shape in Figure 7.8

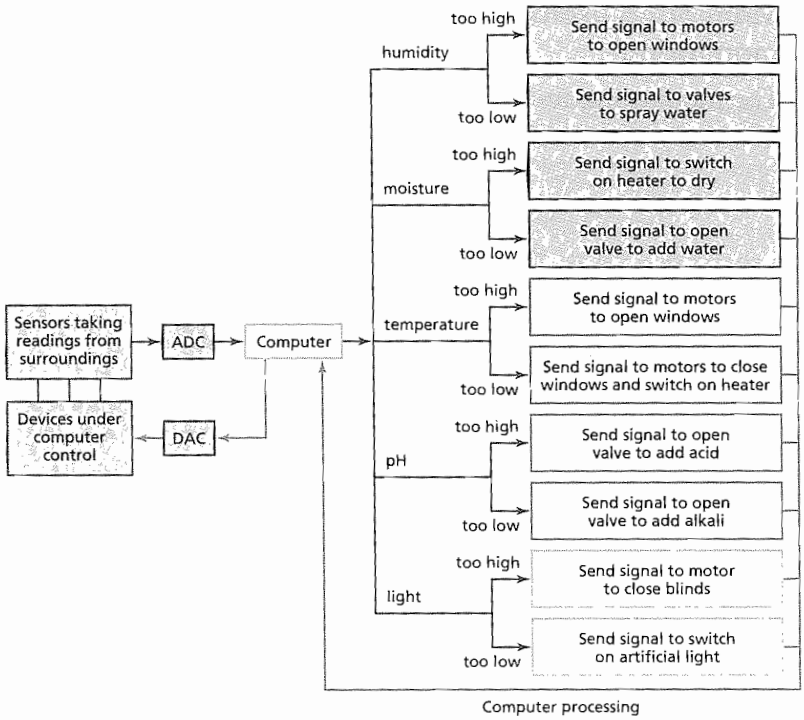


Figure 7.10 The control system for a greenhouse

Control example: chemical process

A certain chemical process only works if the temperature is above 70 °C and the pH (acidity) level is less than 3.5. Sensors are used as part of the control system. A heater is used to warm the reactor and valves are used to add acid when necessary to maintain the acidity. The following description shows how the sensors and computer are used to control this process.

- Temperature and pH sensors read data from the chemical process.
- This data is converted to digital using an ADC.
- The computer compares the incoming data with 'ideal' data stored in memory:
  - If the temperature is too low, a signal is sent to switch on the heaters.
  - If the temperature is too high, a signal is sent to switch off the heaters.
  - If the temperature is within an acceptable range, no action is taken.
  - If the pH is too high, a signal is sent to open a valve and acid is added.
  - If the pH is too low, a signal is sent to close this valve.
  - If the pH is within an acceptable range, no action is taken.
  - The computer signals will be changed into analogue signals using a DAC so that it can control the heaters and valves.
  - This continues as long as the computer system is activated.

Advantages of using sensors and computer systems to control processes

The advantages given earlier for monitoring systems also apply to control systems. However, there are a number of additional advantages:

- The response time if some parameter is out of range is much faster.
- This is safer, as some processes are potentially dangerous if they go wrong – the computer can control the process in a more accurate way, ensuring that the conditions are always correct.
- If a process is dangerous, it is better to control it from a distance.

7.8 Robotics

Robots are used in many areas of manufacturing, from heavy work right through to delicate operations. Examples include paint spraying of car bodies, welding bodywork on cars, manufacturing of microchips, manufacturing electrical goods and automatic warehouses.

Control of robots is either through embedded microprocessors (see Section 7.3) or linked to a computer system. Programming of the robot to do a task is generally done in one of two ways:

- The robot is programmed with a sequence of instructions which allow it to carry out a series of tasks (e.g. spraying a car body with paint).
- Alternatively, a human operator manually carries out a series of tasks and how each task is done is relayed back to the robot (embedded processor) or controlling computer. The sequence of instructions is remembered so that the robot can automatically carry out each task identically each time (e.g. assembling parts in a television).

Robots are often equipped with sensors so they can gather important information about their surroundings. Sensors also prevent them from doing 'stupid things', such as stopping a robot spraying a car if no car is present, or stopping the spraying operation if the supply of paint has run out, etc.

Robots are very good at repetitive tasks. However, if there are many different tasks (e.g. making specialist glassware for some scientific work) then it is often better to still use human operators.

Advantages

- Robots can work in environments harmful to human operators.
- They can work non-stop (24/7).
- They are less expensive in the long term. Although they are expensive to buy initially, they don't need wages.
- Productivity is higher, since they do not need holidays, are not ill, etc.
- There is greater consistency – every car coming off a production line is identical.
- They can do boring, repetitive tasks, leaving humans free to do other more skilled work.

Disadvantages

- Robots find it difficult to do 'unusual' tasks (e.g. one-off glassware for a chemical company).
- They replace skilled labour, leading to unemployment.
- Since robots do many of the tasks once done by humans, there is a risk of de-skilling.
- Because robots are independent of the skills base, factories can be moved anywhere in the world, again causing unemployment.

7.9 Batch processing applications

There are several applications that make use of batch processing, the most common ones being payroll, billing (electricity, gas, water and telephone) and cheque processing.

Payroll

At the end of each pay period (usually weekly or monthly) a company needs to pay its employees. Payroll systems are used to calculate wages and print out pay slips.

- The **inputs** are: employee details from file (e.g. rate of pay, tax code, bank details), number of hours worked (often obtained from a timesheet), any overtime working, holidays, etc.
- The **processing** done is calculation of: gross pay, any deductions (tax, national insurance), net pay, etc.
- The **outputs** are: printed pay slips, updating of the employee file, transfer to Bankers Automated Clearing Service (BACS) if wages paid into a bank account, etc.

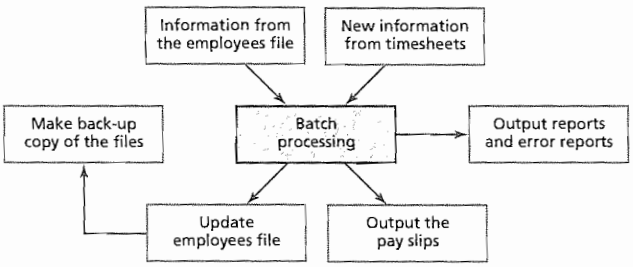


Figure 7.11 The stages in batch processing

This is run as a batch system, where all the timesheets, etc. are gathered together before the payroll calculations are done in one go (often over night). Since there is no need for any further input, nor is it urgent to get the output (unlike in, for example, a booking system), batch processing works efficiently. The process is shown in Figure 7.11.

Billing systems

Because companies send out their bill/invoices on a pre-determined date, all the information is gathered together and then processed in one go (batch). Consider an electricity billing system:

- The **inputs** are: customer details (address), charge per kW (unit) of power, previous readings, new readings taken from the electricity meter, bank account details (if using direct debit), etc.
- The **processing** done is calculation of: number of units of electricity used (i.e. new reading minus old reading), customer's cost (i.e. units used times charge per unit), monthly payments made (if using direct debit), outstanding amount owed or carried over to next bill, etc.
- The **outputs** are: bill showing all the details, updating of customer file, production of request for payment if not done through direct debit, etc.

The diagram of this process is very similar to that shown in Figure 7.11 for the payroll system.

7.10 Automatic stock control system

Automatic stock control systems rely on the use of **barcodes**.

Barcodes now appear on most products sold in shops. They allow quick identification of product details once the barcode has been scanned by a **barcode reader**. Supermarkets, in particular, use **electronic point of sale (EPOS) terminals**, which incorporate a barcode reader that scans the barcode, retrieve the price of the article and relay information back to the computer system allowing it to update its files.

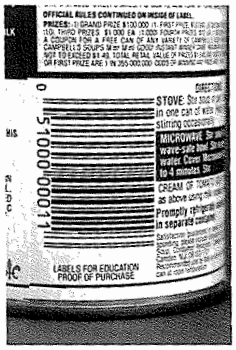


Figure 7.12 An example of a barcode

Barcodes are made up of alternating dark and light lines of varying thickness, as shown in Figure 7.12. A number underneath the barcode usually consists of four parts: country code, manufacturer's code, product code and a **check digit**. The check digit is a form of **validation** which is used to make sure no errors occurred during the reading of the barcode.

The check digit can be calculated in a number of ways. The method discussed here works for codes which contain 11 digits.

Consider the following code:

1	3	5	7	9	11	odd digit positions
5	1	0	4	3	1	1	2	0	1	7	
	2		4		6		8		10		even digit positions

1 Add together the digits in the *odd* positions and multiply the sum by 3:
$5 + 0 + 3 + 1 + 0 + 7 = 16$
$16 \times 3 = 48$

2 Add together the digits in the *even* positions:
$1 + 4 + 1 + 2 + 1 = \mathbf{9}$

3 Add the two results together: $48 + 9 = \mathbf{57}$

4 To find the check digit, calculate what needs to be added to 57 to make the next multiple of 10 i.e. 60. Thus, the check digit is **3**.

Hence the final code is **5 1 0 4 3 1 1 2 0 1 7 3**.

Every time the barcode is read, this calculation is performed to ensure that it has been scanned correctly.

Barcodes are used in the following applications:

- library book systems (see Section 7.13)
- administration systems (e.g. in hospitals)
- passport and ID card systems
- some burglar alarm systems
- equipment checking systems (safety records on maintenance of equipment)
- automatic stock control systems (described in this section).

The following description is a detailed account of how barcodes are used to control stock levels automatically in a supermarket. Other retailers use similar systems with only minor differences.

- Barcodes are attached to all the items sold by the supermarket.
- Each barcode is associated with a stock file, which contains details such as prices, stock levels, product descriptions. The barcode acts as the primary key in the file.
- A customer takes their trolley/basket to the EPOS terminal once they have completed their shopping.
- The barcode on each item is scanned at the EPOS.
- If the barcode cannot be read, then the EPOS operator has to key in the number manually.
- The barcode is searched for on the stock file record by record until a match is found.
- The appropriate record is accessed.
- The price of the item is sent back to the EPOS, together with a product description.
- The stock level for the item is found in the record and is reduced by 1.
- The new stock level is written back to the file.

- If the stock level of the item is less than or equal to the re-order/minimum stock level then the computer *automatically* orders a batch of items from the suppliers. (Supplier information would be found on another file called the order file or supplier file – the barcode would be the link between the two files.)
- Once goods have been ordered, a **flag** is assigned to this item in the file to indicate an order has been placed; this now prevents re-order action being triggered *every time* this item is scanned before the new stock arrives.
- The above procedure is repeated until all the items in the customer's basket/trolley have been scanned.
- When all the items have been scanned, the customer is given an **itemised bill** showing a list (with prices) of everything they have bought.
- The computer updates the files containing the daily takings.
- If the customer has a loyalty card, the system will also automatically update their points total.
- When new goods arrive, the barcodes on the cartons will be used to update the stock files. Also, any flags associated with these goods will be removed so that the stock checks can start to be made again.

Some newer supermarkets now allow customers to scan their own items at special checkouts. These basically work in the same way as the normal EPOS terminals.

7.11 Online booking systems

Online booking systems rely on the ability to update files immediately, thus preventing double booking, which could happen if the system response time was slow. Booking systems are used for transport (flights, trains and buses), cinemas and theatres.

We will consider the theatre booking system to describe how this system works. With this example, we have assumed that the customer has already logged on to the theatre booking website.

- The customer clicks on the performance they wish to see.
- They enter the date and time of the performance and the required number of seats.
- A seating display at the theatre is then shown on the screen and the user clicks on where they would like to sit.
- The database is then searched to check the availability of the selected seats. If the seating plan is shown on screen, this step is not required.
- If the seats are available, the seat numbers are shown together with the total price.
- If the customer is happy with this, they select 'confirm' on the screen.
- The seats are now temporarily set at 'no longer available'.
- The customer then enters their personal details or indicates that they are a returning customer (in which case the website being used will already have their details).
- They select a payment method and make the payment.
- The theatre seats are then booked in the customer's name.
- The final details are shown on the screen, together with a reference number (in case there are any customer queries later on).
- An email is sent to the customer which they print out as their proof of purchase. In some cases, this also acts as their printed ticket when they go to the theatre – an **e-ticket**.
- The database is updated with the transaction.

Booking seats at the cinema is very similar. However, booking flights is slightly more complex since it involves choosing airports, etc. Figure 7.13 shows an example of an online webpage for choosing flights.

Figure 7.13 An online flight booking system

7.12 Banking applications

The use of computer technology has revolutionised how we do our banking transactions, for example:

- internet banking (discussed in Chapter 6)
- the use of automated teller machines (ATMs)
- chip and PIN technology.

Automated teller machines (ATMs)

Automated teller machines (ATMs) are places where customers can get cash (or carry out certain other banking activities such as order a statement) using their credit or debit card. Table 7.3 summarises the process.

Sequence at ATM	What goes on behind the scenes
Customer puts card into ATM.	• Contact is made with bank's computer.
PIN is entered using the keypad.	• PIN is checked to see if it is correct. • Card is checked to see if it is valid.
A number of options are given: • change PIN • top up mobile • see balance • get money.	
The customer selects the cash option. A number of cash amounts are shown.	
The customer accepts one of the options or types in a different amount.	• The customer's account is accessed to see if they have sufficient funds. • It is checked to see if they are withdrawing more than their daily limit.
The customer is asked if they want a receipt.	
The card is returned.	• Transaction is OK.
Money is dispensed.	• Customer's account is updated.

Table 7.3 Process for withdrawing cash from an ATM

Although ATMS are very convenient for customers, they do have a few disadvantages:

- They are often in places where theft can take place unnoticed.
- 'Fake' ATMs can be set up to gather information about the card and retain the card.
- Some banks charge customers for the use of ATMs.
- Someone else could see the PIN being entered and could use this to commit fraud at a later date (also known as 'shoulder surfing').

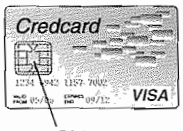


Figure 7.14 A chip and PIN card

Chip and PIN

Many credit cards are equipped with a chip as well as a magnetic stripe (see Figure 7.14) – this contains key information such as the PIN.

This system is designed to enhance security since it is better than relying only on a signature. When paying for items using a chip and PIN card, a form of **electronic funds transfer (EFT)** takes place. In this example, a customer pays for a meal in a restaurant using a chip and PIN card:

- The waiter inserts the card into the chip and PIN reader.
- The restaurant's bank contacts the customer's bank.
- The card is checked to see if it is valid (expiry date, whether stolen card, etc.).
- If the card is stolen or expired then the transaction is terminated.
- The customer enters the PIN using a keypad.
- The PIN is read from the chip on the card and is compared to the one just keyed in.
- If they are the same, then the transaction can proceed.
- If they are different, the transaction is terminated.
- A check is then made on whether they have enough funds.
- If there are not enough funds available, then the transaction is terminated. Otherwise, the transaction is authorised.
- An authorisation code is sent to the restaurant.
- The price of the meal is deducted from the customer's account.
- The same amount of money is credited to the restaurant's bank account.
- A receipt is produced as proof of purchase.

Exercise 7b

Indicate which of the following tasks is batch processing or online (both types).

Description	Batch	Online
Producing a monthly payroll		
Processing bank cheques at the end of the month		
Using an ATM to obtain cash		
Booking seats for a train journey		
Monitoring a patient in an intensive care unit		
Manual stock taking system done at the end of each day		
Welding of a car body using a robot		
A satellite navigation system		
Producing and updating a dictionary or encyclopedia		
Printing out mobile phone bills at the end of the month		
Getting prices of items at an EPOS terminal in a supermarket		

7.13 Library systems

Many library systems are computer controlled. They usually involve the use of barcodes on the books being borrowed and on the borrower's library card (see Figure 7.15).

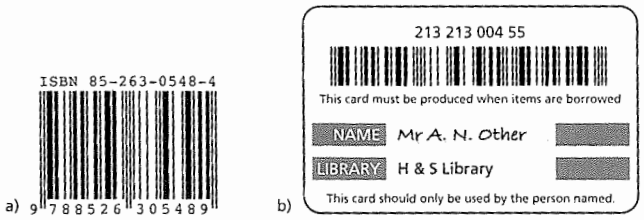


Figure 7.15 Barcodes on a) a library book and b) a library card

- The following describes a computerised library system based on barcodes.
- There are two files:
  - **Book file** (this contains a number of records made up of the following fields):

Barcode	Book title	Name of author	Date published	Number of books	Date due back

  - **Borrower's file** (this contains a number of records made up of the following fields):

Borrower's number	Borrower's name	Borrower's details	Barcode of book borrowed

- When a borrower takes out a book, the book's barcode is scanned. The book details are then found on the **book file**.
- The borrower's library card barcode is then scanned for the borrower's unique number. The **book file** is linked to the **borrower's file** and both files are updated to indicate which book has been borrowed and when it is due back.
- On a daily basis, the **borrower's file** is interrogated by the computer to see which books are overdue for return:
  - The computer reads a record from the book file.
  - It compares the date due back with the current date.
  - If the date due back is **less than (or equal to)** the current date (i.e. earlier date) …
  - … using the barcode number of the book …
  - … the book file is linked to the borrower's file …
  - … and the corresponding record is read from the borrower's file.
  - The customer details are then found and a letter or email is automatically sent out.
  - The next record in the book file is then read …
  - … until the whole file has been checked.

7.14 Expert systems

These systems have been developed to mimic the expertise and knowledge of an expert in a particular field. Examples include:

- diagnosing a person's illness
- diagnostics (finding faults in a car engine, finding faults on a circuit board, etc.)
- prospecting for oil and minerals
- tax and financial calculations
- chess games
- identification of plants, animals and chemical compounds
- road scheduling for delivery vehicles.

A basic expert system is made up of a number of elements, illustrated in Figure 7.16.

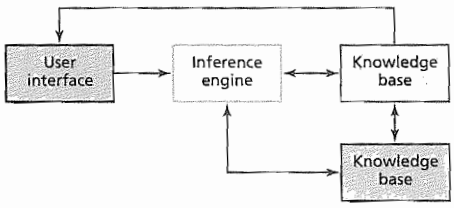


Figure 7.16 Elements of an expert system

How to set up an expert system

- Experts in the field are interviewed to find out what is needed in the expert system.
- Data is then collected from these experts.
- A **knowledge base** (defined below) is designed and then created.
- The **rules base** (defined below) is designed and created.
- An **inference engine** (defined below) is designed and created.
- The **input screen** and output format are also designed and created – this is known as the **user interface**.
- The **expert system** is tested against known conditions and scenarios.
- It is also checked to see if it meets the original specification.
- Experts are interviewed about how effective it is before the expert system goes out on general release.

Advantages

- Expert systems provide consistent answers.
- They never 'forget' to answer a question when determining the logic.
- Using expert systems reduces the time taken to solve a problem.
- A less skilled work force is needed, which gives the potential of saving money, but also allows areas of the world access to expertise which they could not normally afford.

Disadvantages

- They tend to lack common sense in some of the decision-making processes.
- Errors in the knowledge base can lead to incorrect decisions being made.
- It can be expensive to set up in the first place.
- Considerable training is necessary to ensure the system is used correctly by the operators.

Example of an expert system: oil prospecting

- An interactive user screen appears.
- Questions are asked about geological profiles.
- Answers to the questions and information about the geological profiles are typed in.
- The inference engine searches the knowledge base using the rules base.
- The system:
  - suggests the probability of finding oil as an output
  - indicates the probable depth of deposits
  - makes predictions about geological deposits above the soil
  - produces contour maps showing concentration of minerals, rocks, oil, etc.

Definitions of knowledge base, inference engine and rules base

Knowledge base

This is a database designed to allow the complex storage and retrieval requirements of a computerised knowledge-based management system (in support of an expert system).

Inference engine

This is software that attempts to derive answers from the knowledge base using a form of reasoning. It is how expert systems appear to use human-like reasoning when accessing information from the knowledge base in an effort to find a conclusion to a given problem. The inference engine is a type of reasoning engine.

Rules base

This is made up of a series of 'inference rules' (e.g. IF the country is in South America AND the language used is Portuguese THEN the country must be Brazil). These inference rules are used by the inference engine to draw conclusions. They closely follow human-like reasoning.

CHAPTER 8

Systems analysis and design

In this chapter you will learn about systems analysis and design, specifically:

- the analysis stage
- the design stage:
  - validation
  - verification
- the development stage
- the testing stage
- the implementation stage, particularly changeover methods
- documentation
  - user documentation
  - technical documentation
- evaluation.

8.1 Introduction

A **systems analysis** team is often brought in to review an existing system and suggest a number of improvements. The existing method used may be either a manual paper-based system or a computer-based operation that is no longer regarded as adequate for the task.

There are many stages in systems analysis, as shown in Figure 8.1. These are covered in Sections 8.2 to 8.7.

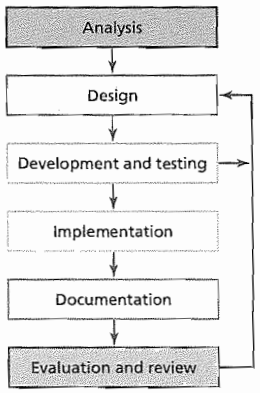


Figure 8.1 The stages in systems analysis

8.2 Analysis stage

The basic steps in the **analysis** stage can be summarised as follows:

1. fact finding/collecting data from the current system
2. description of the current system – establishing the inputs, outputs and processing being done
3. identification of the problems with the current system
4. agreeing the objectives with the customer
5. identifying and agreeing the customer's requirements
6. interpreting the customer's requirements
7. producing a cost-benefit analysis
8. producing a data flow diagram.

Stages 2 to 7 are sometimes referred to as the **feasibility study** and this can be further broken down as shown in Figure 8.2.

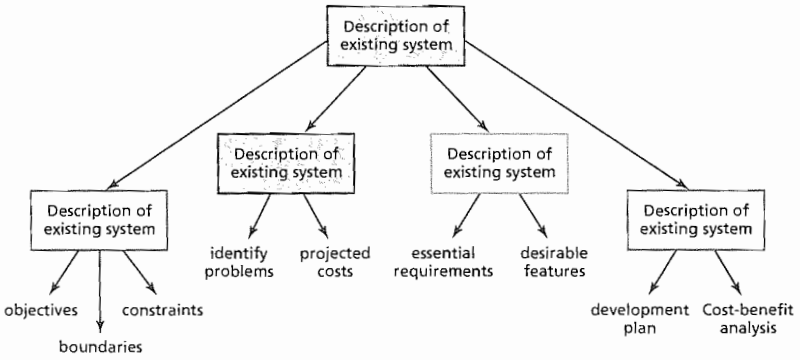


Figure 8.2 Stages in a feasibility study

Let us now consider the first item in the analysis stage – **fact finding**. There are four common methods used in fact finding, which have been summarised in Table 8.1 overleaf. The methods are: **observation, questionnaires, interviews** and **looking at existing paperwork**.

8.3 Design stage

Once the analysis has taken place and the systems analyst has some idea of the scale of the problem and what needs to be done, the next stage is to **design** the key parts of the recommended system. A list of tasks is summarised here, but is by no means exhaustive:

- designing data capture forms/input forms
- designing screen layouts
- designing output forms and reports
- producing systems flowcharts and/or **pseudo code**
- selecting and designing validation rules that need to be used
- selecting the most appropriate data verification methods
- designing and agreeing the file structures and tables
- selecting and designing the hardware requirements
- selecting and designing the software requirements
- producing algorithms or program flowcharts
- designing a testing strategy/plan.

We will now consider in more depth two of these tasks: **verification** and **validation**.

Verification

Verification is a way of preventing errors when data is copied from one medium to another (e.g. from paper to disk/CD). There are two common ways that verification checks are carried out:

- **Double entry**: in this method, data is entered *twice*, using two different people. The computer compares the two entries, either after data entry or during the data entry process, and identifies any differences.
- **Visual check**: this is the checking for errors by comparing entered data on the screen with the data in the original document (this is *not* the same as proof reading).

Validation

Validation is a process where data is checked to see if it satisfies certain criteria when input into a computer, for example to see if the data falls within accepted boundaries. A number of validation techniques exist and Table 8.2 highlights some of the more common ones used when writing computer software.

Name of method	Description	Advantages	Disadvantages
Observation	Involves watching personnel using the existing system to find out exactly how it works.	• The analyst obtains reliable data. • It is possible to see exactly what is being done. • It is a relatively inexpensive method.	• People are generally uncomfortable being watched and may work in a different way. • If workers perform tasks that violate standard procedures, they may not do this while being watched!
Questionnaires	Involves sending out questionnaires to the work force and/or to customers to find out their views of the existing system and find out how some of the key tasks are carried out.	• The questions can be answered quite quickly. • It is a relatively inexpensive method. • Individuals can remain anonymous if they want. • It allows quick analysis of the data.	• Often the number of returned questionnaires is low. • The questions are rather inflexible since they have to be generic. • There is no immediate way to clarify a vague or incomplete answer to a question.
Interviewing	Involves a one-to-one question-and-answer session between the analyst and the employee/customer.	• It gives the opportunity to motivate the interviewee into giving open and honest answers to the analyst's questions. • It allows the analyst to probe for more feedback from the interviewee, as it is easier to extend a question. • It is possible to modify questions as the interview proceeds and ask questions specific to the interviewee. • It is a good method if the analyst wants to probe deeply into one specific aspect of the existing system.	• It can be rather time consuming. • It is relatively expensive, due to the use of the analyst's time. • The interviewee cannot remain anonymous.
Looking at existing paperwork	Allows the analyst to see how the paper files are kept, look at operating instructions and training manuals, check the accounts, etc.	• It allows information to be obtained which was not possible by any of the other methods. • The analyst can see for themselves how the paper system operates. • It allows the analyst to get some idea of the scale of the problem, memory size requirements, type of input/output devices needed, etc.	• It can be very time consuming. • Because of the analyst's time, it is a relatively expensive method.

Table 8.1 Different fact finding methods

Validation check	Description	Example/s
Range check	Checks whether data is within given/acceptable values.	A person's age should be in the range > 0 but < 150.
Length check	Checks if the input data contains the required number of characters.	If a field needs six digits then inputting a five- or seven-digit number, for example, should cause an error message.
Character/type check	Checks that the input data does not contain invalid characters.	A person's name should not contain any numbers but a person's height should only contain digits.
Format/picture check	Checks that data is in a specific format.	Date should be in the form dd/mm/yyyy.
Limit check	Similar to range check except that only *one* of the limits (boundaries) is checked.	Input data must be > 10.
Presence check	Checks if data is actually present and has not been missed out.	In an electronic form, a person's telephone number may be a required field and if no data is present this should give rise to an error message.
Consistency check	Checks if fields correspond (tie up) with each other.	If 'Mr' has been typed into a field called **title** then the **gender** field must contain either 'M' or 'Male'.
Check digit	Looks at an extra digit which is calculated from the digits of a number and then put on the end of the number (see example in Section 7.10).	Check digits can identify three types of error: • if two digits have been inverted during input, e.g. 13597 instead of 13579 • an incorrect digit entered twice, e.g. 13559 typed in instead of 13579 • a digit missed out altogether, e.g. 1359 typed in instead of 13579.

Table 8.2 Common validation methods

8.4 Development and testing

Once the design stage is completed, it is then necessary to create the system and fully test it. This section considers some of the development stages and testing strategies which are often adopted by systems analysts.

Development stages

If the system contains files (e.g. a database) then the file structure needs to be finalised at this stage (e.g. what type of data is being stored in each field, length of each field, which field will be the key field, how the data files will be linked, etc.). Once the file structure has been determined, it is then created and fully tested to make sure it is robust when the system actually goes live.

Since it is important that the correct data is stored in files, there are certain techniques that need to be adopted to make sure the data populating the file/s and database/s is at least of the right type and that it conforms to certain rules. Validation routines and verification methods (discussed in Section 8.3) are used to ensure this happens. Again, these routines have to be fully tested to ensure they do trap unwanted data but also to make sure any data transferred from a paper-based system to an electronic system has been done accurately.

Any system being developed will have some form of user interface. The types of hardware were chosen in the design stage. How these are used to interface with the final system now needs to be identified, for example how the screens (and any other input devices) will be used to collect the data and the way the output will be presented. If specialist hardware is needed (e.g. for people with disabilities), then it will be necessary to finalise how these devices are used with the system when it is implemented. This will be followed by thorough testing to ensure the user screens are user friendly and that the correct output is associated with the inputs to the system.

Testing strategies

Testing of each module needs to be done to ensure each one functions correctly on its own. Once the development of each module is completed, the whole system needs to be tested (i.e. all modules functioning together). Even though each individual module may work satisfactorily, when they are all put together there may be data clashes, incompatibility and memory issues, etc.

All of this may lead to a need to improve the input and output methods, file and database structures, validation and verification methods, etc. Then the system will need to be fully tested again. It is a very time-consuming process but the system has to be as perfect as possible before it goes live.

Testing will use many different types of data, which will fall into one of three categories: normal, extreme or abnormal. Let us suppose one of the fields in a database is the date and this must be in the form dd/mm/yyyy, where each element of the date must be numeric:

- **Normal**: this is data which is acceptable/valid and has an expected (known) outcome, e.g. the month can be *any* whole number in the range 1 to 12.
- **Extreme**: this is data at the limits of acceptability/validity, e.g. the month can be either of the two end values i.e. 1 *or* 12.
- **Abnormal**: this is data outside the limits of acceptability/validity and should be rejected or cause an error message. For example, all the following values are not allowed as inputs for the month:
  - negative numbers (e.g. –1, –15)
  - any value greater than 12 (e.g. 32, 45)
  - letters or other non-numeric data (e.g. July)
  - non-integer values (e.g. 3.5, 10.75).

8.5 Implementation

Once the system is fully tested, the next stage is to fully implement it. Some of the stages in this process are shown in Figure 8.3.

We will now consider changeover to the new system in more depth. As indicated in Figure 8.3, there are four common methods used for changing over from the old system to the new system. Each one has advantages and disadvantages, shown in Table 8.3, which need to be weighed up before the most appropriate method is chosen for a particular application.

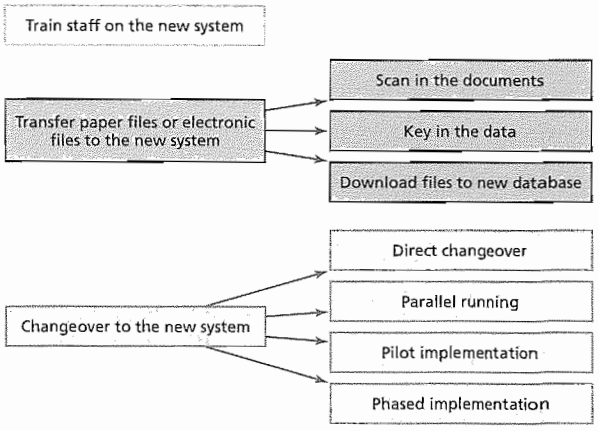


Figure 8.3 The implementation stage

Changeover method	Description	Advantages and disadvantages
Direct	The old system is stopped overnight and the new system introduced immediately.	• The benefits are immediate. • Costs are reduced – since only one system is used there is no need to pay for two sets of staff. • There is less likelihood of a malfunction since the new system will have been fully tested. • This method can be disastrous if the new system fails.
Parallel running	The old and new systems are run side by side for a time before the new system takes over altogether.	• If the new system fails, the old system is still available as a back-up. • It is possible to train staff gradually. • Staff have time to get used to the new system. • It is more expensive than direct changeover, since extra staff are needed to run both systems together.
Pilot implementation	The new system is introduced into one part of the company (e.g. into a warehouse of a supermarket) and its performance assessed.	• If the new system fails, only one part of the company is affected. • It is possible to train staff in one area only, which is much faster and less costly than parallel running. • The costs are also less than parallel running, since only one part of the system is being used in the pilot. • It is more expensive than direct changeover, since each pilot scheme needs to be evaluated before the next stage is introduced.
Phased implementation	Initially, only part of the new system is introduced. Only when it proves to work satisfactorily is the next part introduced, and so on, until the old system is fully replaced.	• If the latest part fails, it is only necessary to go back in the system to the point of failure, hence failure is not disastrous. • It is possible to ensure the system works properly before expanding. • This is more expensive than direct changeover, since it is necessary to evaluate each phase before moving to the next stage.

Table 8.3 Changeover methods

Table 8.4 compares the costs, input requirements and risk of failure for all four changeover methods.

Changeover method	Relative costs	Input needed by the user	Input needed by systems team	Impact of failure
Direct	Low	Medium	Low*	High
Parallel	High	High	Low	Low
Pilot	Medium	Low	Medium	Low
Phased	Medium	Medium	Medium	Medium

* Low if successful, otherwise *very high* amount of input needed

Table 8.4 Comparison of the four changeover methods

8.6 Documentation

Once the new system is fully developed, a considerable amount of documentation needs to be produced a) for the end user, and b) for people who may need to modify or develop the system further at some later stage. There is some overlap between the two types of documentation, but the basic requirements are shown below.

User documentation

User documentation is designed to help users to learn how to use the software or system. This can consist of any of the following:

- the purpose of the system/program/software package
- how to log in/log out
- how to load/run the software
- how to save files
- how to do a search
- how to sort data
- how to do printouts
- how to add, delete or amend records
- screen layouts (input)
- print layouts (output)
- hardware requirements
- software requirements
- sample runs (with test data and results)
- error handling/meaning of errors
- troubleshooting guide/help lines/FAQs
- tutorials.

Technical documentation

Technical documentation is designed to help programmers and analysts who need to make improvements to the system or repair/maintain the system. This can consist of any of the following:

- purpose of the system/program/software
- program listing/coding
- programming language used
- flowchart/algorithm

- input formats
- hardware requirements
- software requirements
- minimum memory requirements
- known bugs in the system
- list of variables used (and their meaning/description)
- file structures
- sample runs (with test data and results)
- output formats
- validation rules
- meaning of error messages.

8.7 Evaluation

Once a system is up and running it is necessary to do some **evaluation** and carry out any maintenance, if necessary. The following is a list of some of the things considered when evaluating how well the new system has worked. This can ultimately lead back to a re-design of part of the system if there is strong evidence to suggest that changes need be made. If you look back to Figure 8.1 in Section 8.1, you will see that the evaluation stage feeds back into the design stage. To evaluate the system, the analyst will:

- compare the final solution with the original requirement
- identify any limitations in the system
- identify any necessary improvements that need to be made
- evaluate the user's responses to using the new system
- compare test results from the new system with results from the old system
- compare the performance of the new system with the performance of the old system
- observe users performing set tasks, comparing old with new
- measure the time taken to complete tasks, comparing old with new
- interview users to gather responses about how well the new system works
- give out questionnaires to gather responses about the ease of use of the new system.

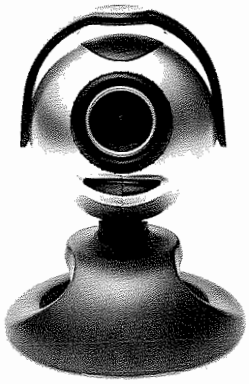
Some results from the evaluation may require changes to either hardware or software. Hardware may need to be updated because:

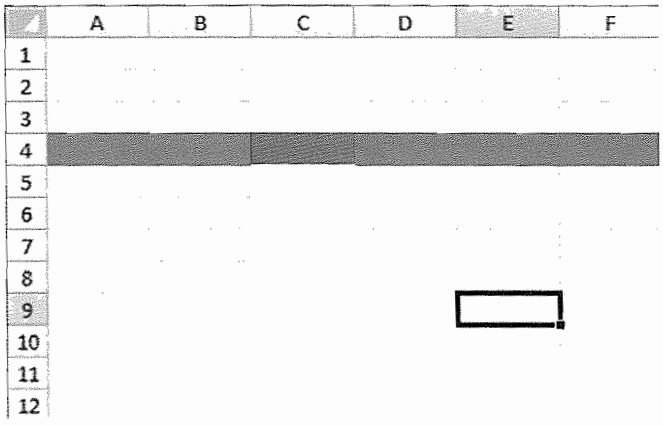
- of feedback from end users
- new hardware comes on the market, making change necessary
- there are changes within the company which require new devices to be added or updated.

Software may need to be updated because:

- of feedback from end users
- changes to the company structure or how the company works may need modifications to the software
- changes in legislation may need modifications to the software.

Part 2

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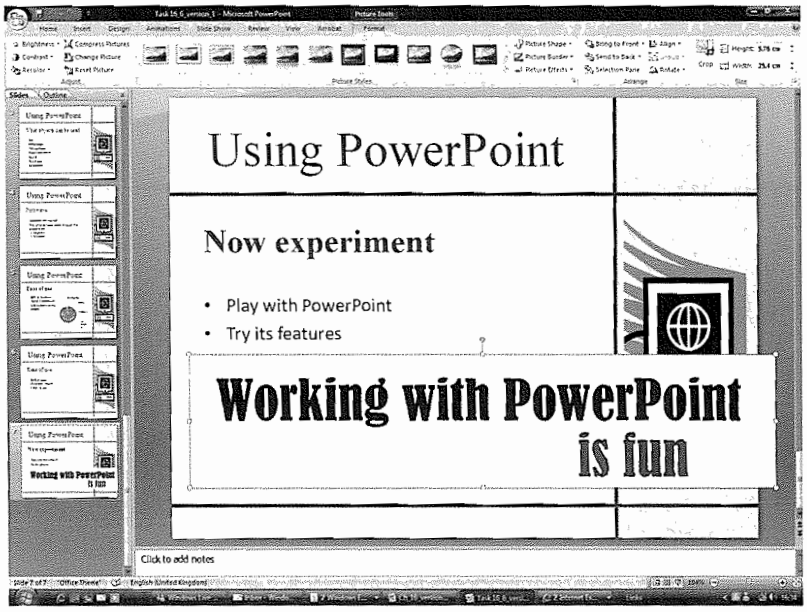
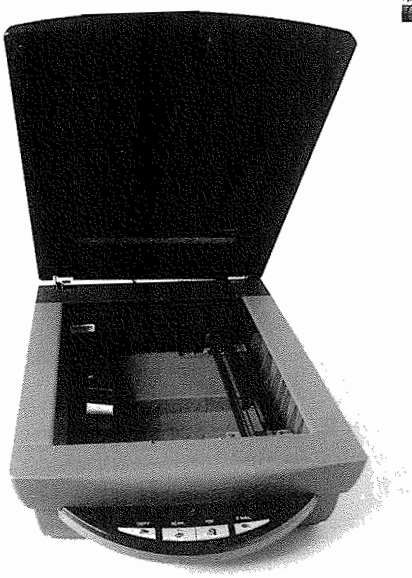
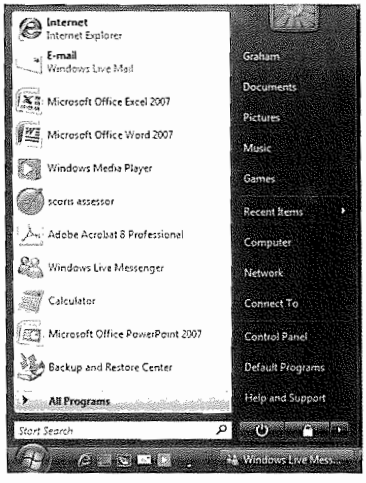

Using PowerPoint
Now experiment
• Play with PowerPoint
• Try its features
Working with PowerPoint is fun
Click to add notes




Internet
Internet Explorer
E-mail
Windows Live Mail
Microsoft Office Excel 2007
Microsoft Office Word 2007
Windows Media Player
scoris assessor
Adobe Acrobat 8 Professional
Windows Live Messenger
Calculator
Microsoft Office PowerPoint 2007
Backup and Restore Center
All Programs
Start Search
Graham
Documents
Pictures
Music
Games
Recent Items
Computer
Network
Connect To
Control Panel
Default Programs
Help and Support

CHAPTER 9

Communication

In this chapter you will learn how to:

- open your mailbox
- organise your mail
- use email etiquette
- send an email
- send a file as an email attachment
- receive an email
- receive and save a file as an email attachment
- reply to an email
- forward an email
- copy an email to another mail recipient
- manage your email contact lists
- locate and download information from the internet
- use the internet to locate information on a specified website
- use the internet to search for information using a search engine.

For this chapter you will need this source file from the CD:

- STYLE1.CSS

9.1 Using email

Email is short for 'electronic mail' and is a method of sending text-based messages from one computer to another or using mobile phones. Email is usually received instantaneously by the recipient's mail provider and frequently waits there until the user accesses their mailbox. Some mail providers will allow users to have their messages forwarded to their mobile phones. All mailboxes have a storage limit and it can be very easy to fill your mailbox. If this happens, you will not be able to receive the messages sent to you.

Hint

Your email system will be protected by a password. Make sure that you keep your password secure.

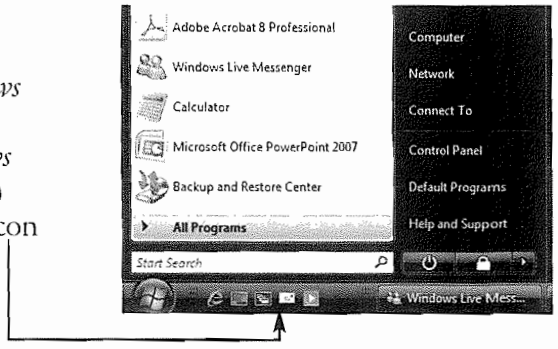
To use email you must have a mailbox with an email address. These can be web based like *Windows Live Mail* or use an internally hosted mailbox, which is common in many schools. For this chapter, I have created a new email account with *Windows Live Mail*. Although I will use this for the exercises in this chapter, most of the skills are transferable to other email editors and the underlying structures are the same.

9.2 Opening your mailbox

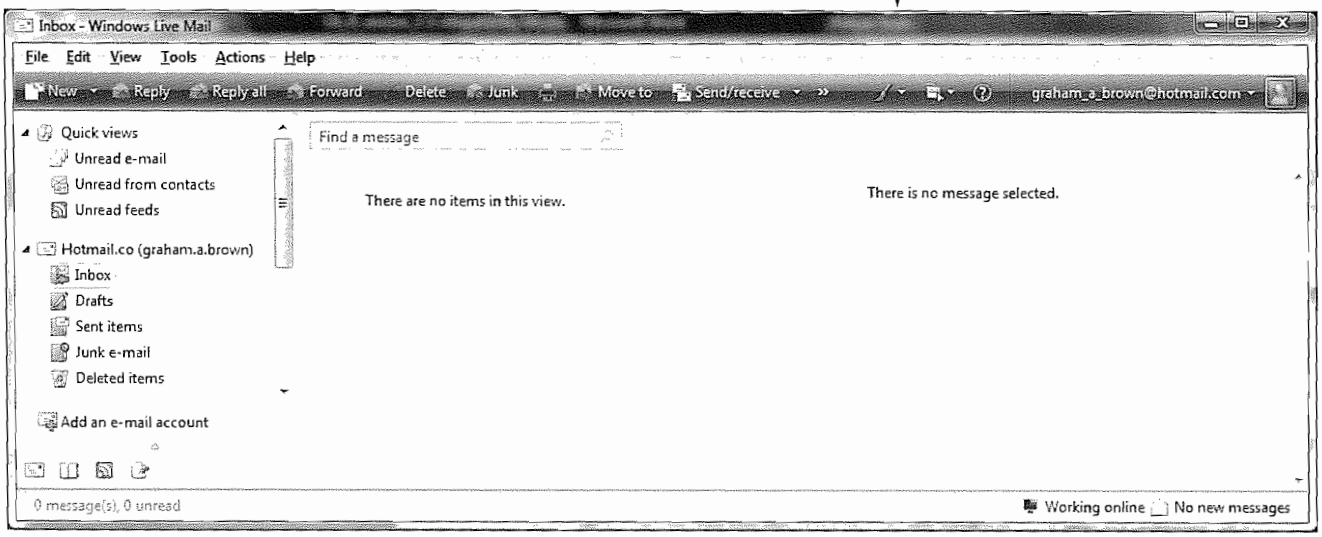
Hint

If this icon does not appear, select the **Start** button, followed by **All Programs** and **Windows Live Mail**.

To open your mailbox, go to the *Windows* taskbar, usually found along the bottom of the screen. Select the icon for *Windows Live Mail* (it looks like a white envelope) and click the left mouse button on this icon to open the email editor.



Your email editor will open and look similar to this. You may need to enter your email address and password in some systems.



9.3 Organising your mail

At the moment the mailbox is empty, but it will soon fill with a flood of messages. These will need organising into logical groups. You need to decide on the groups you want and then create and name folders to match these groups.

Task 9a

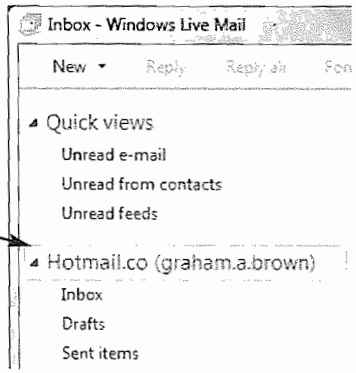
Create new folders in your email editor called 'IGCSE ICT' and 'Friends'.

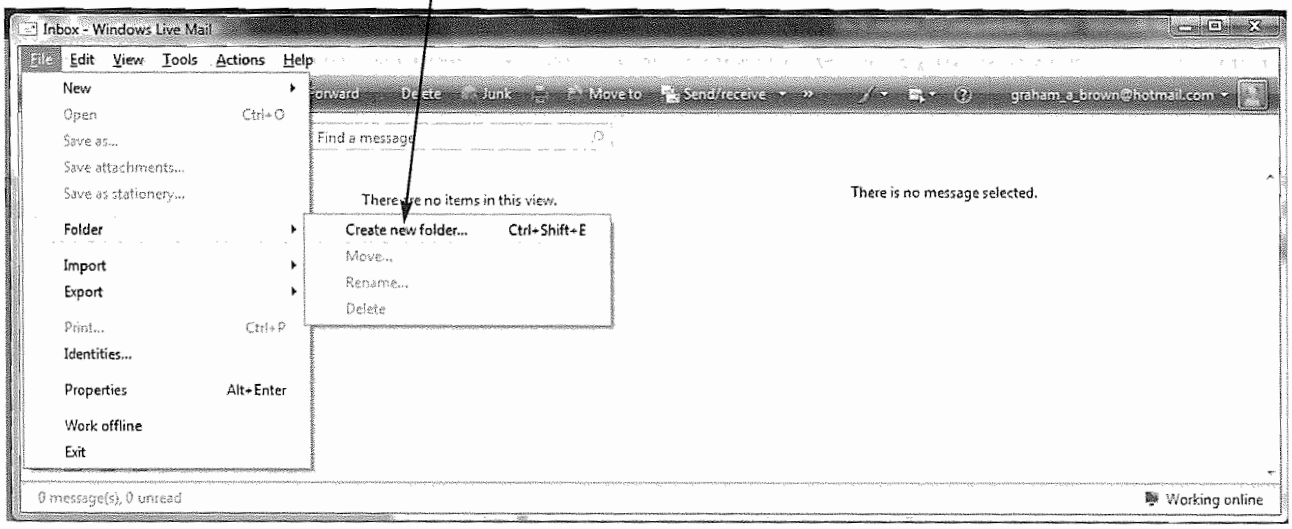
Hint

If the menu bar is not visible, click on the New button, and select Folder from the pull-down list.

Select your email account by clicking on your email address in the left column of the email editor.

Select the **File** menu, followed by **Folder**, then **Create new folder...** like this.

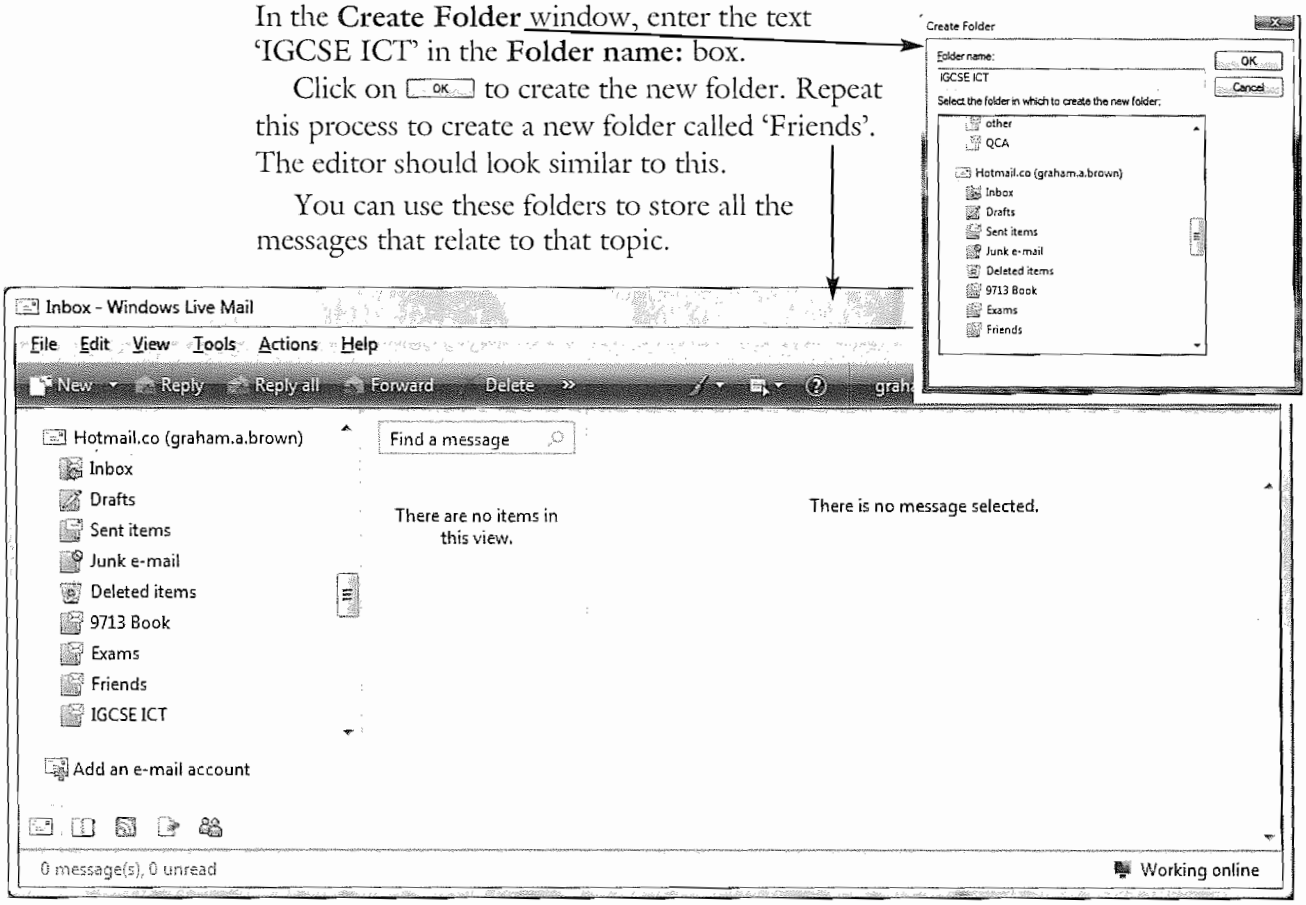




In the **Create Folder** window, enter the text 'IGCSE ICT' in the **Folder name:** box.

Click on OK to create the new folder. Repeat this process to create a new folder called 'Friends'. The editor should look similar to this.

You can use these folders to store all the messages that relate to that topic.



9.4 Email etiquette

When using email, use these basic rules to help you to gain respect of other online users:

- Do not type using all capital letters – this is read as shouting in an email.
- Do not leave the subject line blank.
- Do not use coloured text and backgrounds. These are more difficult to read and can take up a lot of space in an email inbox.
- When sending a number of people the same email use 'bcc' rather than 'cc' as it protects their email addresses from being passed on and reduces the chance of them getting junk mail.
- Do not forward chain letters and similar types of email as these can take up valuable space in an email inbox.
- Do not give out any personal details like phone numbers, passwords, bank account details, etc. in emails.
- Email communication is private. In most countries, you are likely to be breaking the law if you post the content of an email to you in a public place without the sender's permission.
- Compress or **zip** email attachments where possible before sending them. This will allow larger documents or other files to be sent quickly and take up less storage space in the inbox.

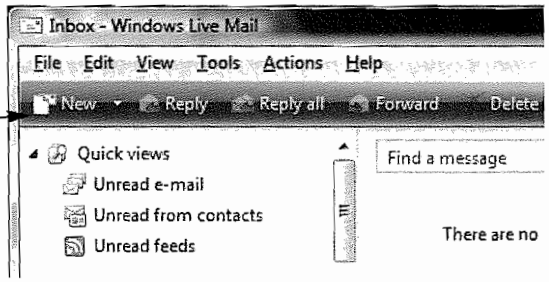
9.5 Sending an email

Task 9b

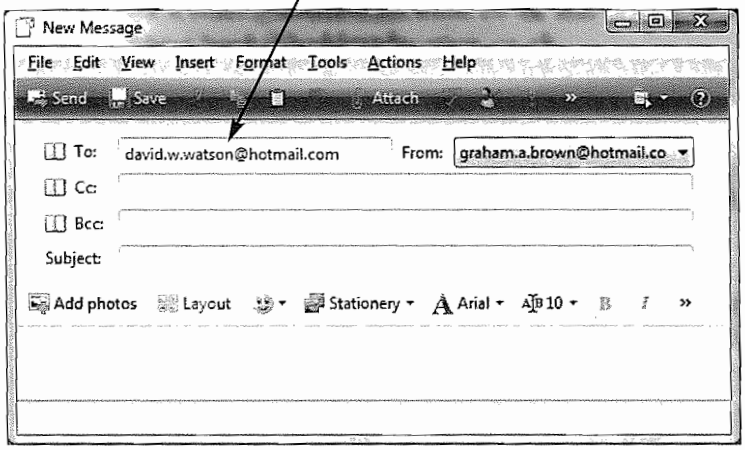
Send an email message to David Watson. Use the email address david.w.watson@hotmail.com and let him know that some of the source files for Chapter 15 of the book are almost complete. Copy this message to a user with the email address a.n.other@hoddereducation.co.uk and send a blind carbon copy to best.book@hoddereducation.co.uk.

Make the subject line for the email '0417 IGCSE text book'

Open your email editor and access your mailbox, using your email address and password. Click on **New** to create a new email message.



This opens the **New Message** window. Enter the email address of the person that you wish to send the email to in the **To:** box. In this case the message will be sent to David Watson.



Make sure that you type the address accurately, carefully checking spelling and punctuation. One error in your typing will mean that the message will not be sent to the correct person. This person will not be aware that you have ever sent them a message. If you have contacts that you email often, add them to your contacts list (sometimes called an address book), and select them from there. This reduces the chance of errors when typing the email address. Clicking the left mouse button on the To: icon opens the contacts list.

If you wish to send a copy of the message to another person, add their name to the **Cc:** (carbon copy) box. Again, if the person's name is already in your contacts list, use the Cc: icon to find and add their email address. For this task, a copy of the message will be sent to a.n.other@hoddereducation.co.uk so include this address in the carbon copy box.

Hint

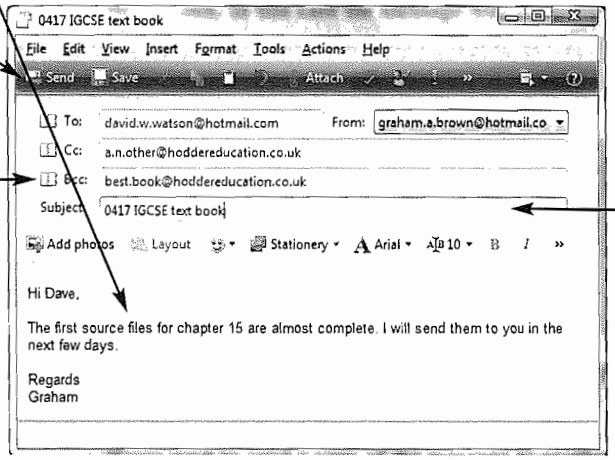
If the Cc: and Bcc: options cannot be seen, click on **Show Cc & Bcc** to get these boxes

You can also copy the message to another person using **Bcc** (blind carbon copy). None of the people receiving the message will be aware that a copy of it has been sent to anyone in the **Bcc:** box. It also prevents the email address that was used for the blind carbon copy being passed to other people. For this task a blind carbon copy is to be sent to best.book@hodder education.co.uk, so include this address in the **Bcc:** box.

The subject line of a message lets the person receiving the email know what the message is about. This will allow them to read the most urgent messages first. Add the subject line '0417 IGCSE text book' in the **Subject:** box.

Enter the content of the message in the main message box. Remember to use a greeting at the start of the message and a salutation at the end.

When you have checked your email to make sure that there are no errors, click on **Send**. The email will then be sent to the mailbox of each person in the **To:**, **Cc:** and **Bcc:** boxes.



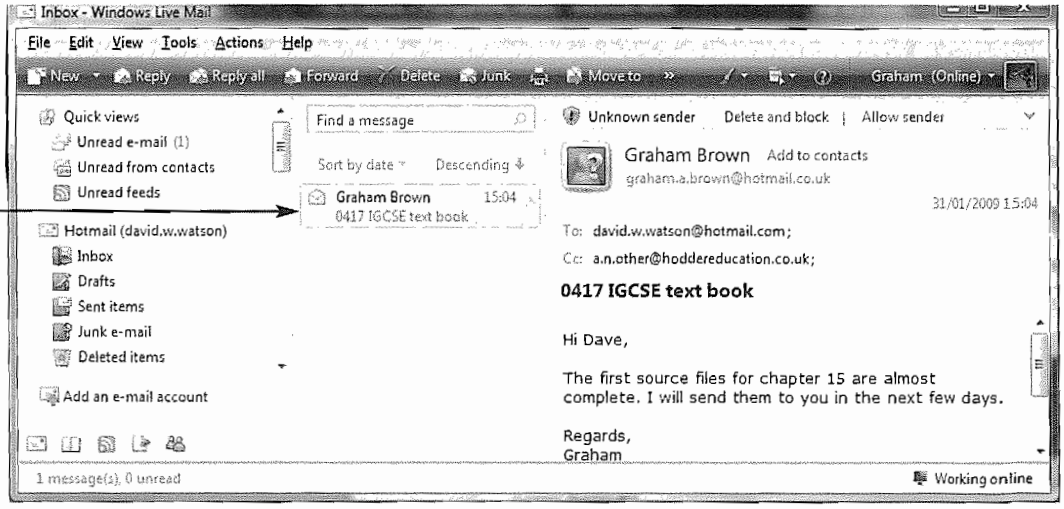
Activity 9a

Send an email to your teacher with the subject line 'email'. Copy this to two other people in your class, informing them that you can now send them messages using email. Your tutor will send you a reply, which will set you another task.

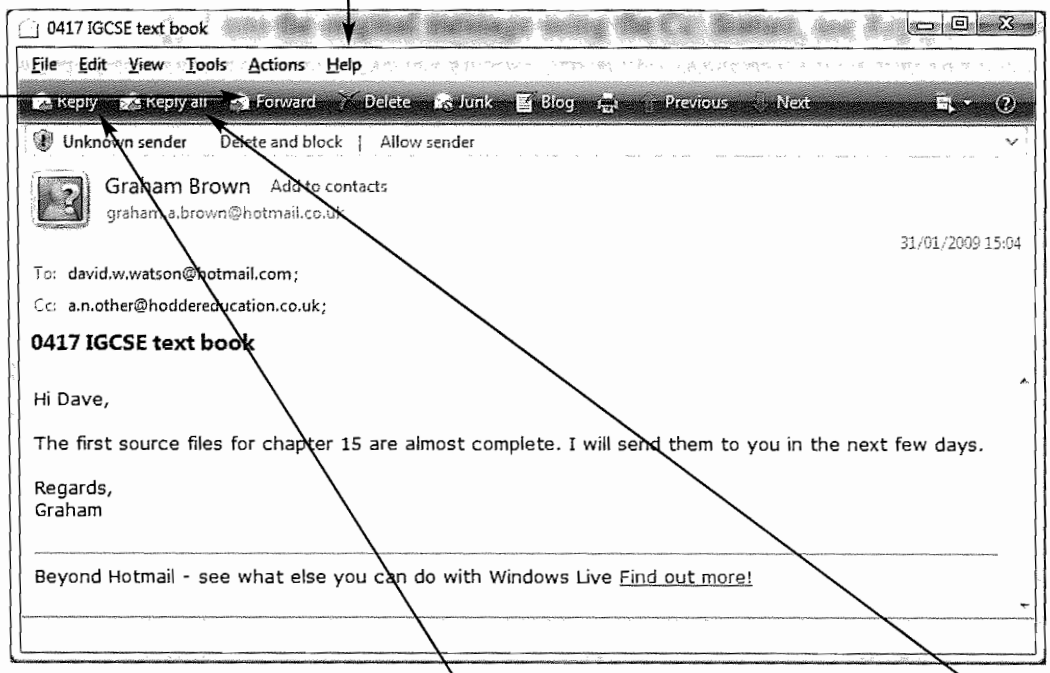
9.6 Receiving an email

Click on the **Inbox** for your email account. Any emails received will appear in this window. In this example, the new email message has been received and can be seen here. New (unopened) messages appear in bold in this centre column of the window.

Double clicking the left mouse button on the message will open it in a new window and will look similar to this.



To reply to the message click on **Reply**, or to reply so that all the people placed in the **To:** box and **Cc:** box in the original message can see the reply click on **Reply all**.

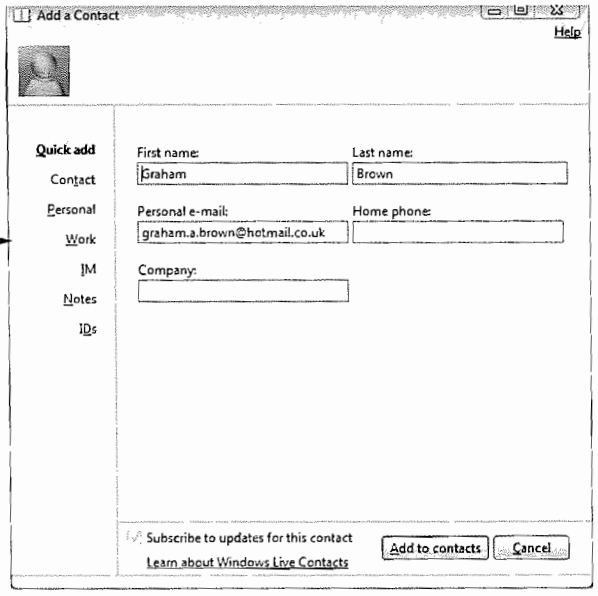


If you wish to send this message to another person without adding to the contents use **Forward**.

Using the **Reply** or **Reply all** options allows you to add your text to the message, but send the original message as well. You may notice that the email addresses of the people who were blind carbon copied into this message are not visible to the other people receiving the message, unlike those who were carbon copied.

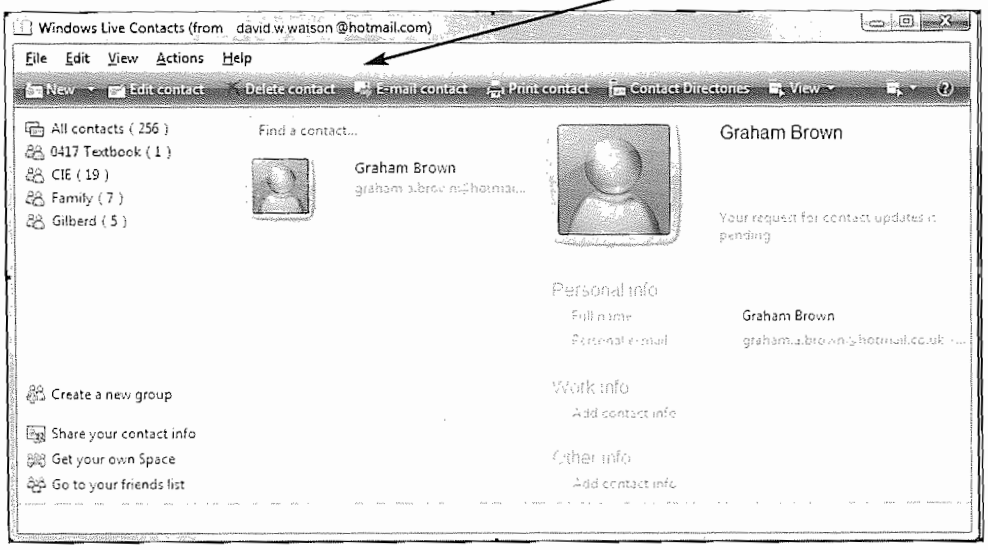
9.7 Managing your contacts

You can add a contact to your address book when they send you an email message. As you can see there is an option to add this sender to your contacts list. Click on the **Add to contacts** hyperlink to open the **Add a Contact** window.



Some of the details have been automatically filled in from the email you were sent. Complete any other personal details that you wish to include on the forms. You can include more contact details using the tabs down the left side. When you have completed the form, this person can be added to your list of contacts by clicking on Add to contacts.

Your contacts list can be managed by selecting the **Tools** menu in *Windows Live Mail*, and clicking on **Contacts...**. This will open the **Contacts** window.



New contacts can be added, existing contact details edited and contacts deleted from this window. You can also organise your contacts into groups. You can use these groups to send a single email to all of the people in a group at the same time by selecting the group name rather than contact name. You can create multiple groups and contacts can belong to more than one group. Groups can be deleted by right mouse clicking on the group name then selecting **Delete Category** from the drop-down menu. Deleting a group does not delete the contacts in it and removing a contact from a group does not delete the contact from your address book. Your contact details can be shared with others using this system, but this is not recommended.

Activity 9b

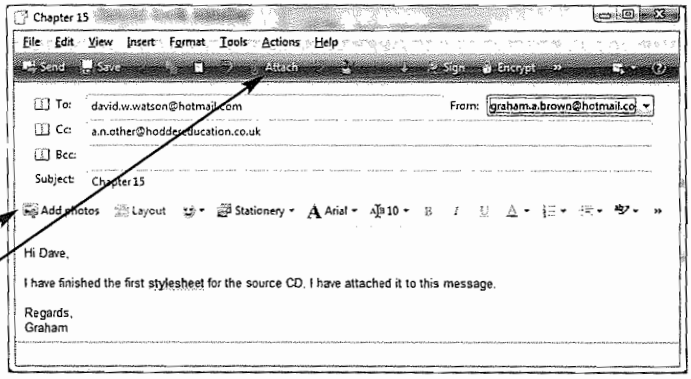
Add the email addresses and other contact details of two of your friends to your contact list. Check that these contact details work by sending them a test email. Reply to messages sent by your friends letting them know that the details are correct.

9.8 Sending a file using email

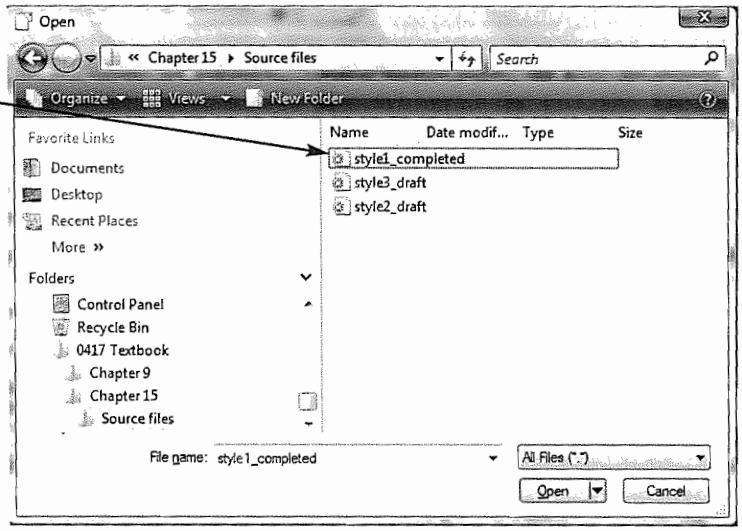
Task 9c

Send an email message to David Watson and a copy to a.n.other@hoddereducation.co.uk with the file STYLE1.CSS (from the CD) attached to the message. Make the subject line for the email 'First stylesheet'.

Prepare the email for sending as you did in Task 9.2. Enter the email addresses, subject line and the body of the message. The completed message should look similar to this.

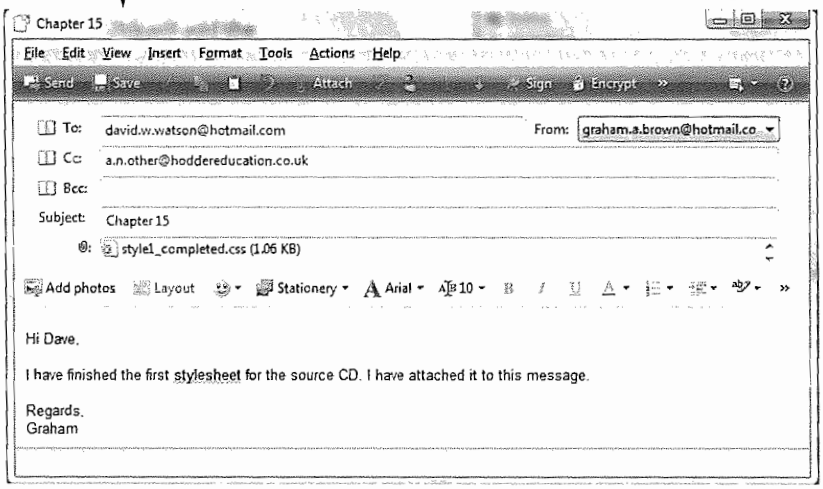


Click on **Attach** to start the process of attaching the file to the message. This opens the **Open** file window.



Select the file to be sent before clicking on Open.

This will add the file as an attachment to the message. This process can be repeated to attach multiple files to a message. When you have checked the message and it is ready to be sent, click on **Send**.

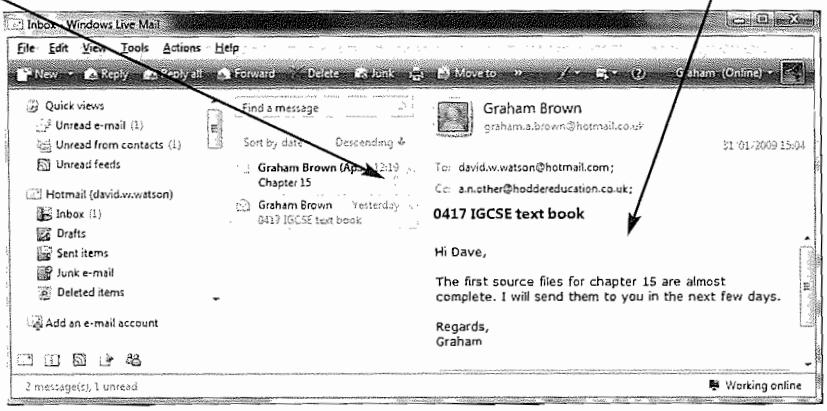


Activity 9c

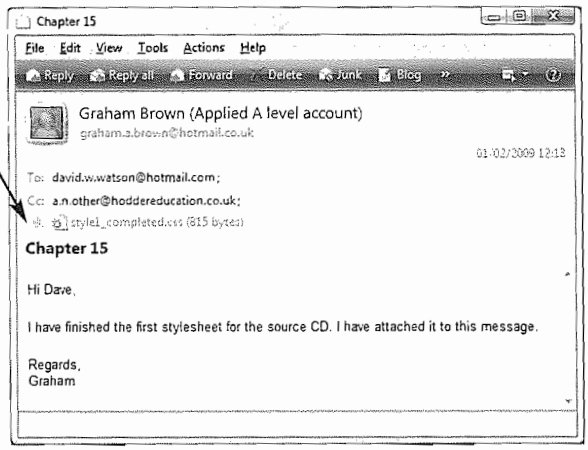
Read the reply that your teacher sent you after Activity 9a. Reply to this email, sending them the document that they have asked for with your notes in it.

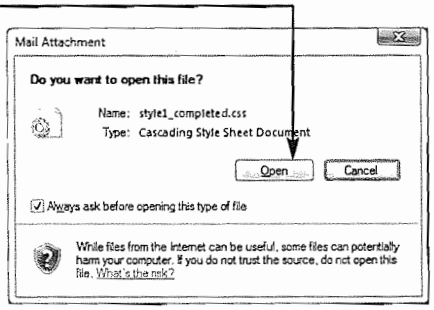
9.9 Receiving and saving a file using email

Click on the **Inbox** for your email account. All messages that you have received will appear in this window. In this example, a new email message has been received. The paperclip shows that the message has an attachment. Open this message by double clicking the left mouse button on the sender's name. The message will look similar to this.



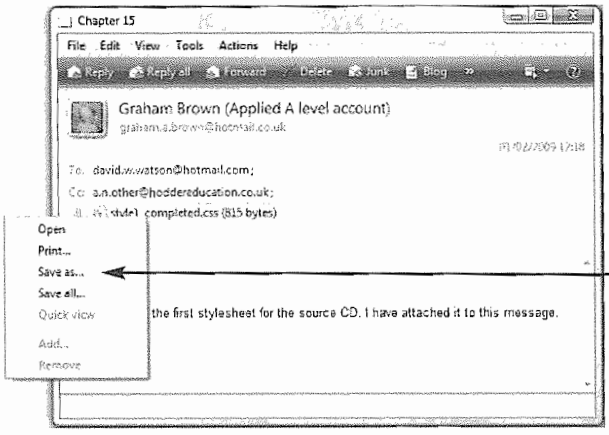
To open the attachment, double click the left mouse button on the attachment name. Then click on Open in the **Mail Attachment** window.





If you prefer to save the file, right mouse click on the attachment name to get a drop-down menu.

To save a single file use **Save as...** (**Save all...** is useful for multiple files), which opens the **Save Attachment As** window. Choose the filename and the folder location for the file, then click on Save.



Hint

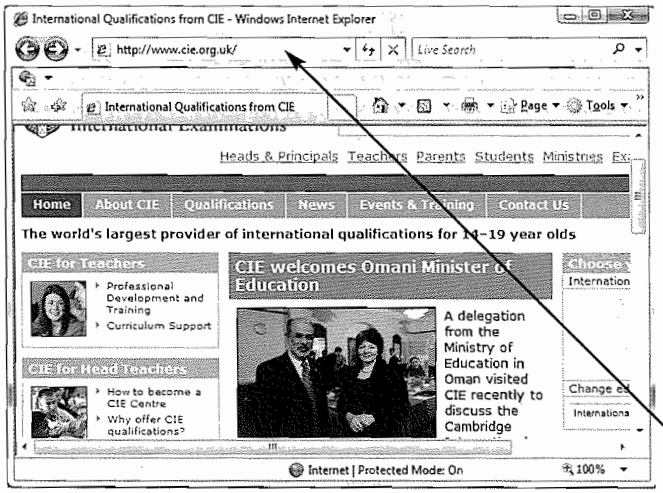
Email attachments can be used to send viruses. Do not open an attachment unless you are expecting it and know and trust the sender.

9.10 Using the internet

The internet is a **wide area network**, made from a number of individual computers and networks linked together to form one large network. It is worldwide and can be accessed by anyone with an internet connection. Anyone can add information to or have a server on the internet. This means that some information on the internet is incorrect, biased or unreliable, although other information is reliable and factual.

There are two ways of locating information from the internet. The first is by accessing sites that you know about using their URL. The second method is finding the information that you are looking for, but you do not know where to look. This method involves using a search engine.

9.11 Opening a website from a URL

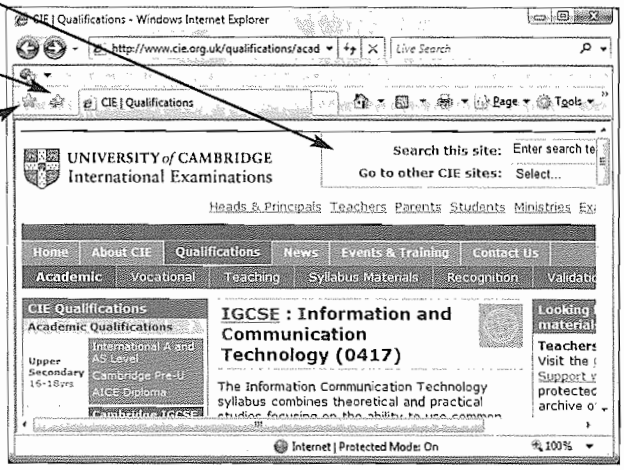


URL is short for **uniform resource locator**, which is the unique address given to any document found on the internet. The URL contains two parts: the first is the type of protocol being used (e.g. http://) and the second is the name of the computer (e.g. www.cie.org.uk). There may be a third part which gives the pathway within this computer.

Open your web browser and type the URL of the site that you require in the Address bar, followed by the <Enter> key. In this case the address added is for the homepage of the CIE website.

If you know the URL for a page within the website, you can type the full entry into the browser to get to a particular page. For example if you wanted the 0417 page within this site you would enter this URL: http://www.cie.org.uk/qualifications/academic/middlesec/igcse/subject?assdef_id=969 to obtain this page of the website.

To avoid having to retype long URLs like this, use the **Add to Favorites** icon to store this URL in your browser. To open your stored favourites, use the **Favorites** icon.



9.12 Using a search engine

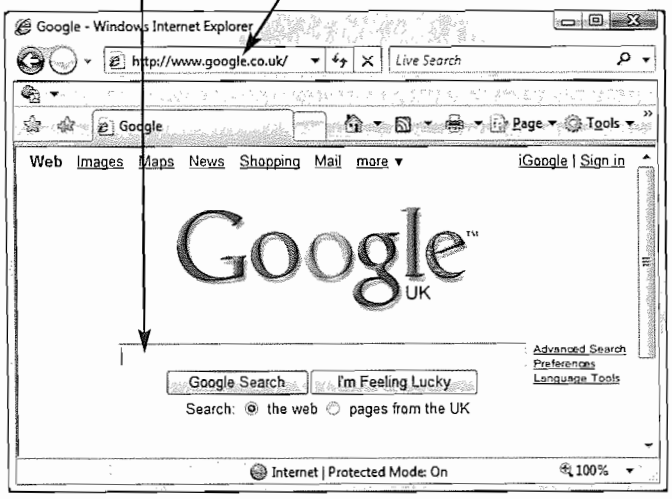
A **search engine** is useful if you do not know the URL of a website or if you want information and do not know where to look. There are many search engines that appear to use different methods, but the underlying function of all search engines is the same. They take the words that you enter as a **search string** and look up in their database of **webpages** those that appear to match your search string. The more detail that you put into your search string the more likely the search engine is to find the results you require.

Task 9d

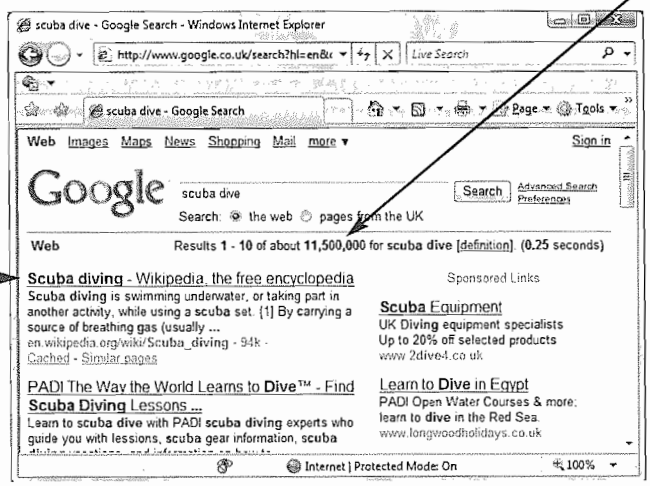
Search the Internet for information on 'learn to scuba dive' in your country in preparation for a scuba diving trip to the Red Sea.

Open a webpage with a search engine. In this case you are going to use the URL www.google.com. As this has been entered into the browser, this has been re-routed to a local version of the website hosted in the UK.

To search for a topic enter the search string in this box.

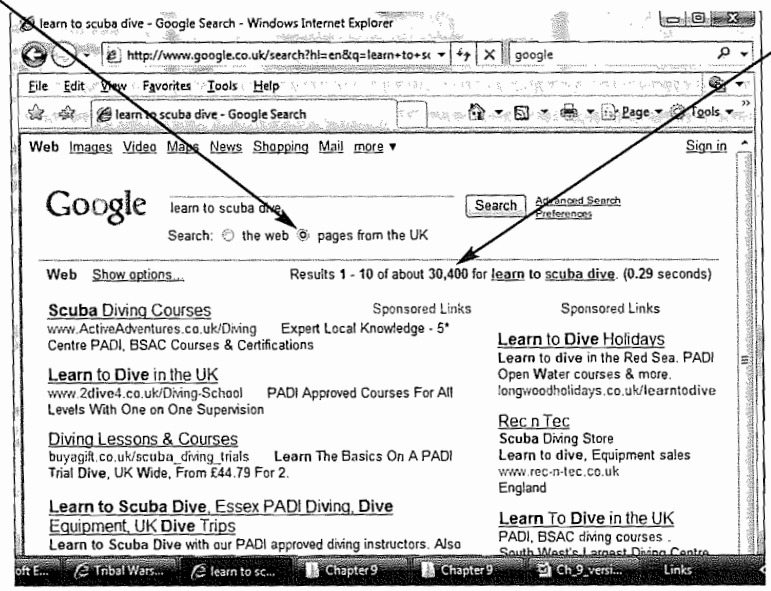


Your choice of search string is very important. If you type only the words 'scuba dive' then click on Google Search, the search engine will find these results. You can see that the search engine has found eleven and a half million possible webpages.



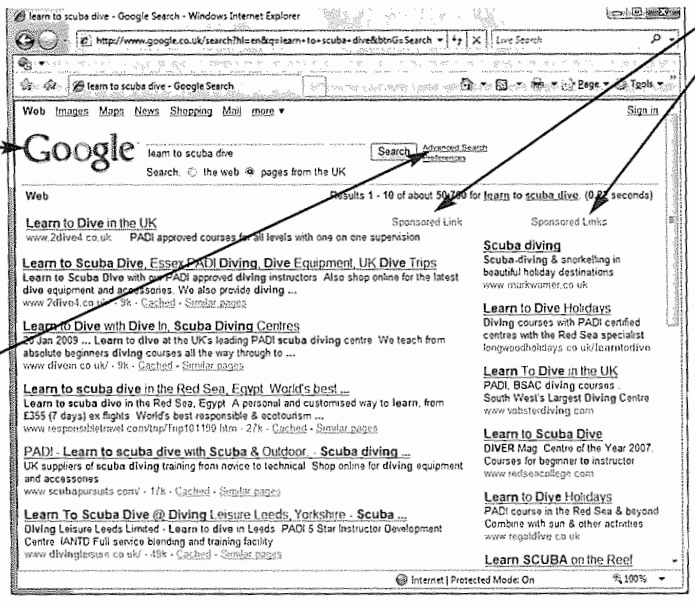
To improve the search you can select the **pages from the UK** radio button (this may vary depending upon your location). This would make sure that only local sites are included in the search results. Changing the search string to include 'learn to scuba dive' will also reduce the number of web pages found.

These two stages have reduced the number of possible webpages to just over thirty thousand.



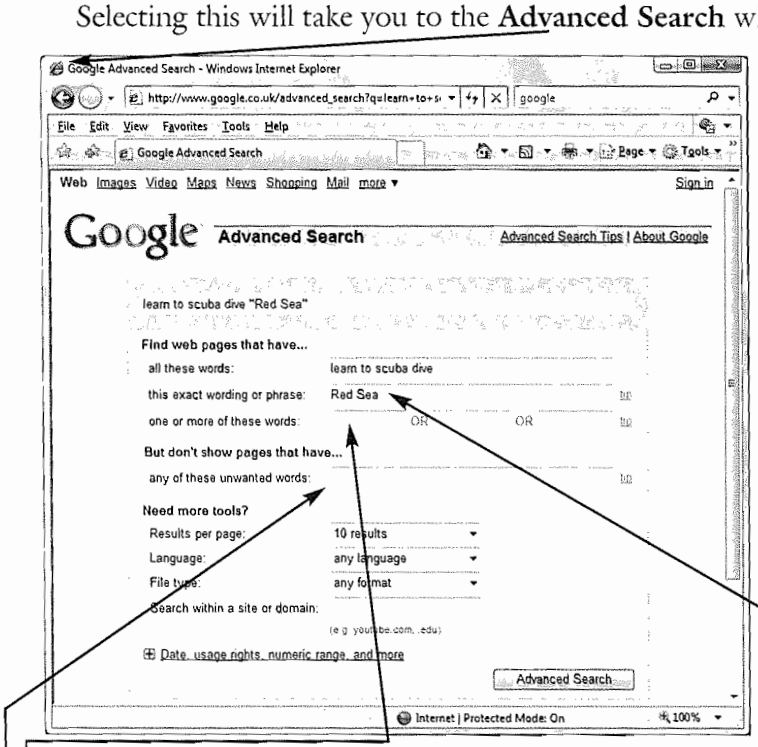
The results of this search appear on the page.

Most search engines will show sponsored links as the first few results of the search. These are websites that have paid money to have their webpages at the top of the results, in the hope that this will bring them more customers. These are not always the best links to use. Some search engines will tell you that this has happened like this.



This search could be refined further by adding the name of the local town or city in the search string. A better way to refine your searches is to use the advanced search option available in many search engines.

Selecting this will take you to the **Advanced Search** window.



If an exact phrase needs including in the search, like 'Red Sea', place this text here.

This would find any websites relating to the phrase 'Red Sea' but not find either the word 'Red' or the word 'Sea' on their own.

If there are words that you need to have one OR another included in the search these can be placed here.

If there are other words that you want excluding from the search place these here.

All of these options could be used to find the site or sites that you require. Look carefully at the URLs and brief descriptions of each site to help you decide which site or sites might be more suitable for you.

Search engines can also be used in a website to search only within that site. These are sometimes used in the practical examinations. If you need to use one of these, take care to enter meaningful search strings, taken directly from the information in the question paper. Each search engine works in a different manner and instructions on saving and downloading are always given.

Hint

Spelling errors in search strings are the most common reason for search errors. To help solve these problems, enter the search string into your word processor, check the spelling, then cut and paste the search string into your web browser.

CHAPTER 10

Document production

In this chapter you will learn how to:

- enter data from an existing file
- key in and edit text
- import images from a variety of sources
- place and manipulate images
- set the page size and orientation
- set page margins
- use headers and footers
- set page, section and column breaks
- use columns
- set font styles and sizes
- emphasise text
- use lists
- use tables
- align text
- set line spacing
- correct errors.

For this chapter you will need these source files from the CD:

- ACTIVITY3.RTF
- SNOWBALL.JPG
- TABLE1.CSV
- TABLE2.CSV
- TEXT1.RTF
- TEXT2.RTF
- TEXT3.RTF
- TEXT4.RTF
- TEXT5.RTF
- TEXT6.RTF
- TEXT7.RTF
- TREES.JPG

You will also need this source image for scanning:

- SNOWANGEL

You will find this image at the end of the book, on page 300.

10.1 Generic file types

The practical examinations will ask you to open and edit data that is supplied to you in the examination. These files will be saved in a file format that can be opened in suitable software on all types of computer. For the examinations you must be able to open documents from generic file types and understand their features and limitations. Common generic files include:

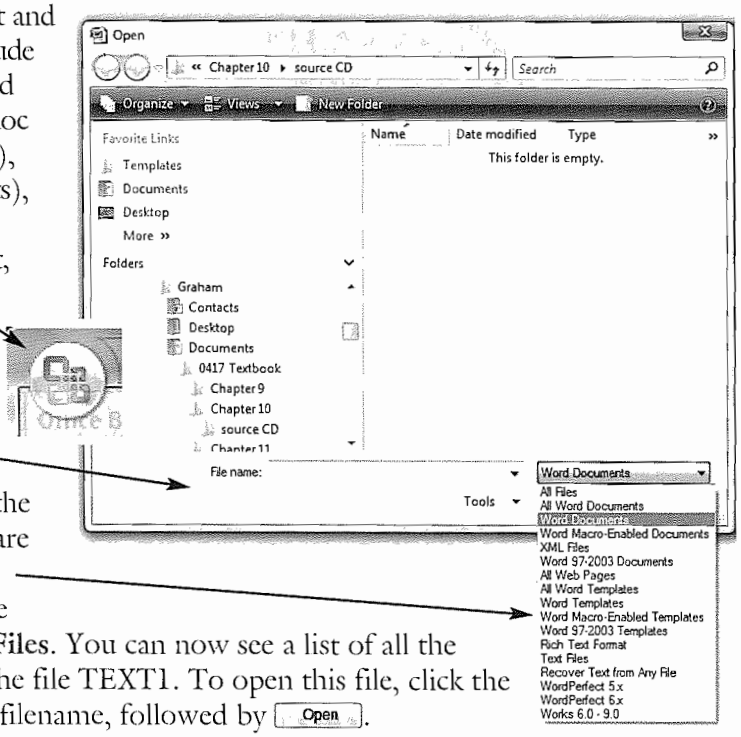
- comma separated values: these files have a .csv file extension. This file type takes data in the form of tables (that could be used with a spreadsheet or database) and saves it in text format, separating data items with commas
- text: these files have a .txt file extension. A text file is not formatted and can be opened in any word processor
- rich text format: these files have a .rtf file extension. This is a text file type that saves some of the formatting within the text.

10.2 Entering data from existing files

Task 10a

Open the file TEXT1.RTF and insert the file TABLE1.CSV as a table within the document.
Change the document heading to 'Winter weather forces schools to close'.
Save the document as Ch_10_Task_10a in your word processor's normal format.

You can use a variety of text and document formats and include them as part of your finished document. These include .doc (*Microsoft Word* documents), .docx (also *Word* documents), .rtf and .txt formats. Open *Word*. To open a document, select the **Office** button in the top left corner of the window, then click on **Open** to obtain this window.

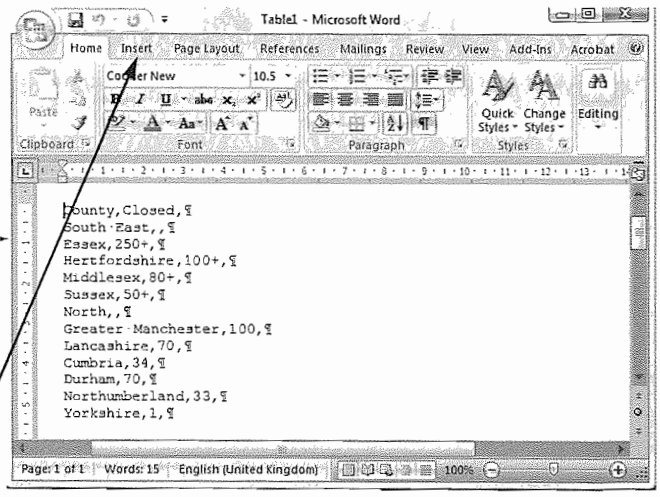


Change the file types that can be opened using the drop-down menu. If you are unsure of the file type and wish to see all the available files in a folder select **All Files**. You can now see a list of all the available files, including the file TEXT1. To open this file, click the left mouse button on the filename, followed by Open.

Use the **Office** button and **Save As...** to save this document with the filename Ch_10_Task_10a as a *Word* document, rather than in rich text format.

Now open the file TABLE1.CSV as a new *Word* document. An alternative to copying and pasting the table into the document would be to place the .csv file in the document as an **embedded object**. This is really useful if you wanted to update the table within another package like a spreadsheet, but is not as useful in the practical examinations where it is unlikely that you will have time to keep updating objects embedded into a document.

The file TABLE1.CSV looks like this when it has been opened in *Word*.

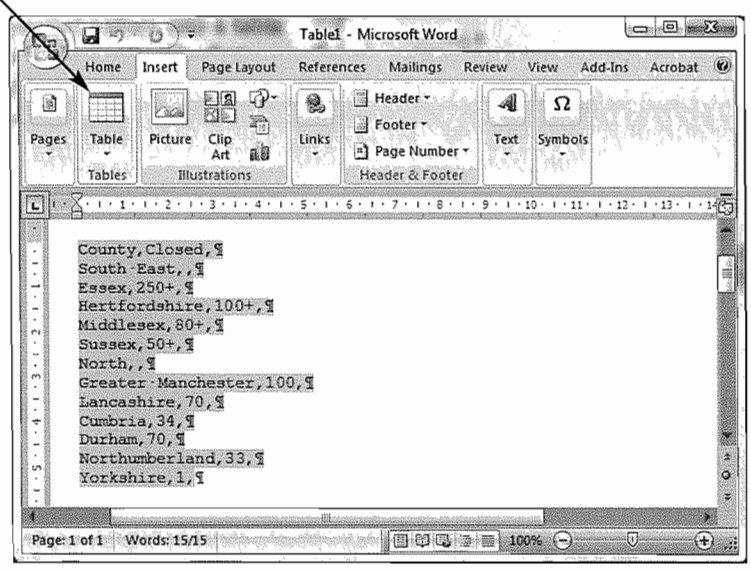


Now you need to edit it, to turn the comma separated values into a table and copy it into the file that you recently saved. Highlight all the text and then select the **Insert** tab.

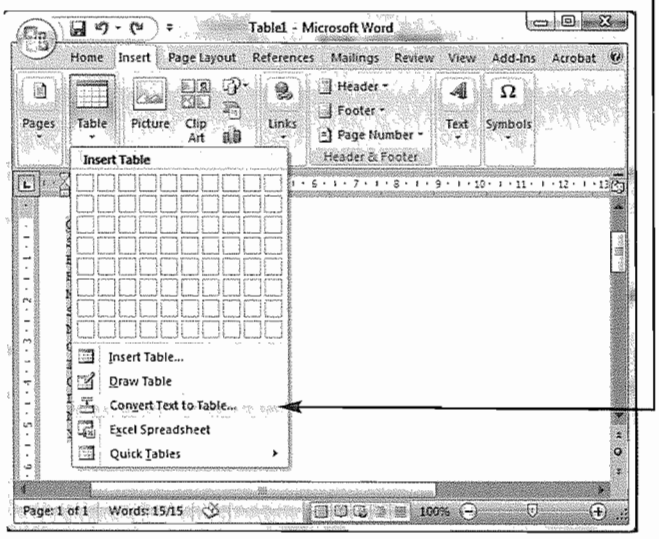
Hint

If you have to combine more than one file (sometimes with different file types), open each file as a new document, then copy and paste from one document to another. This method can reduce any problems that could occur with embedded objects.

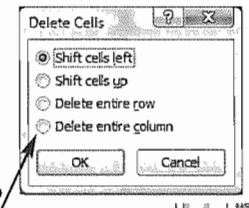
Select the **Table** icon, then **Convert Text to Table...**. Because the text is highlighted it will be placed within the cells of a table.



This opens the **Convert Text to Table** window. Click on OK to create the table. If Word has not offered you the correct values for rows and columns because the .csv file contains both commas and carriage returns, then the table may need editing by either removing blank rows and/or columns. In this example, it has created an extra column to the right.

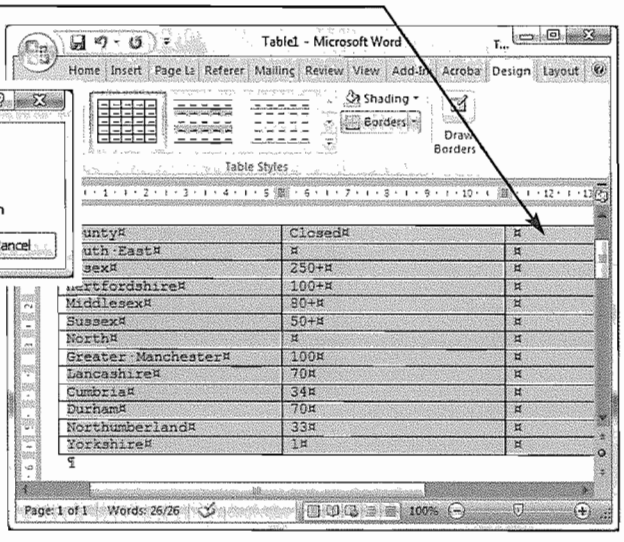


To remove this column, first click the left mouse button in a cell in the right-hand column. This removes the highlighting from the table. In the same cell, right mouse click to obtain a drop-down menu. From this menu select the **Delete Cells...** option.



Choose the radio button for **Delete entire column** followed by OK.

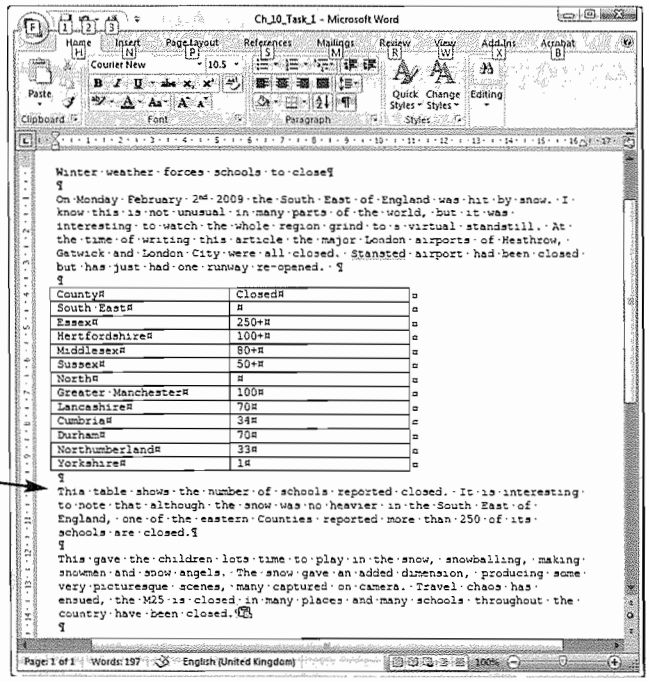
Copy this table and paste it in place of the text **<Place table here>** in the document that you saved as Ch_10_Task_10a. This task is continued in the next section.



10.3 Keying in text

To change the document heading, highlight the existing heading and overtype this with the new heading. Although this seems one of the easiest tasks in the practical examinations, it is one where a significant number of students fail to check their data entry. You will need to be one hundred per cent accurate with all data entry, including the use of capital and lower case letters. The document should now look like this.

Save the changes to this document.



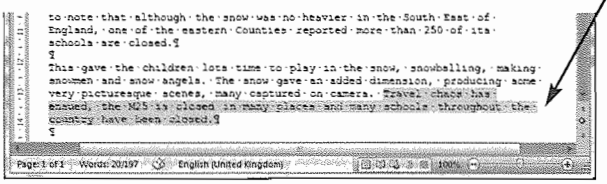
10.4 Editing text

Task 10b

Open the file Ch_10_Task_10a.
Move the last sentence in the document so that it becomes the last sentence in the first paragraph.
Add a new subtitle 'School closures' just above the table, and add this short paragraph:
The dramatic change in the weather has meant that a number of areas are experiencing transport problems. This means that many schools across the country have been closed.'
between the subtitle and the table.
In the third paragraph change the word 'was' to 'is', and add the word 'has' between 'Counties' and 'reported'.
Save the document as Ch_10_Task_10b in your word processor's normal format.

There are a number of techniques that could be used to move the last sentence to the end of the first paragraph. These include **cut** and **paste**, **copy** and paste then delete the original and drag and drop. It is recommended that you learn and practise all of these methods.

All three methods require you to highlight the correct section of text. A useful tip (especially if you are right-handed) is to highlight from the end of the text back to the beginning rather than the other way around. Highlight the text like this.



Hint

Drag and drop is easy when both positions are on the screen at the same time, but harder when you need to scroll through the document before dropping.

You can now choose your method from:

1. **Cut and paste**
   Right mouse click within the highlighted area to get the drop-down menu, then select **Cut**. This removes the sentence and places it in the windows clipboard. Move the **cursor** to the end of the first paragraph and right mouse click to obtain the drop-down menu again. This time select **Paste**.

2 **Copy, paste and delete**
   Right mouse click within the highlighted area to get the drop-down menu, then select **Copy**. This copies the sentence to the clipboard but does not remove it. Move the cursor to the end of the first paragraph and right mouse click to obtain the drop-down menu and select **Paste**. Move back to the original sentence, highlight it and press the <Delete> key on the keyboard. Although this method takes longer than method 1, it does not remove the original sentence until the end of the process, so if you accidentally lose the sentence from the clipboard the original is still present.

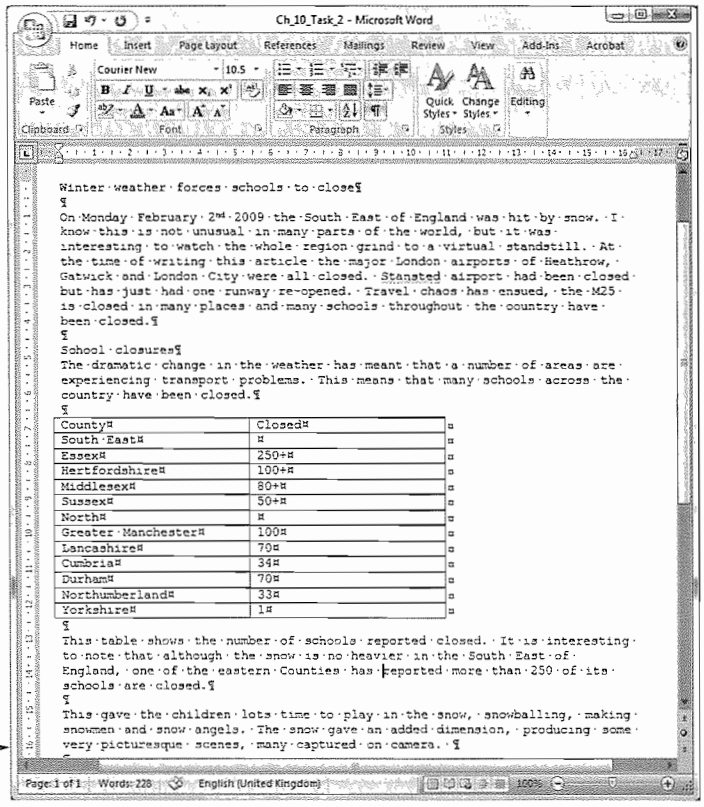
3 **Drag and drop**
   Click the left mouse button in the highlighted area and hold this down, moving the cursor to the end of the first paragraph. Release the left mouse button at that point and you will drop all of the highlighted text there.

Whichever method you have used, make sure that the character spacing between the sentences and the line spacing between paragraphs matches the rest of the document. In the practical examinations you are likely to be penalised for any inconsistencies.

To add the subtitle, move the cursor to the end of the first paragraph and press the <Enter> key twice. (This will keep the same paragraph spacing as the rest of the document). Now type the text 'School closures' followed by the <Enter> key. Type the new paragraph. Go back and check for data entry errors and the consistency of spacing. Correct any errors.

To change the word 'was' to 'is', locate the word and highlight it. Type in the word 'is' and it will replace the original. To insert the word 'has', place the cursor between the words 'Counties' and 'reported'. Ensure that there is a single space on each side of the cursor before you type the word 'has'.

Save your document with a new filename. The finished document should look like this.



Activity 10a

Hint

To import images from a scanner or digital camera, the hardware device must have been installed on the computer first or the device will not work.

1 Open the file TEXT2.RTF and insert the file TABLE2.CSV as a table within the document after the paragraph that ends 'This table shows the number of schools closed in some of the local authorities:'.
2 Change the document heading to 'Snow brings disruption to Britain'.
3 Move the last paragraph in the document so that it becomes the first paragraph.
4 Add the text 'Heavy snowfalls were reported to the north of London. London was also affected but not to the same extent as the disruption that had been caused the week before.' as a new paragraph immediately before the paragraph that starts 'Flights were suspended ...'.
5 In the last paragraph change the word 'weird' to 'unusual' and add the word 'national' between 'many' and 'newspapers'.
6 Save and print this document.

10.5 Importing images

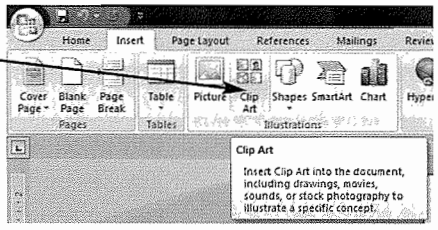
Images for the practical examination can be imported from clip art, a digital source like a scanner or digital camera, a file supplied to you, or an image from a website.

Task 10c

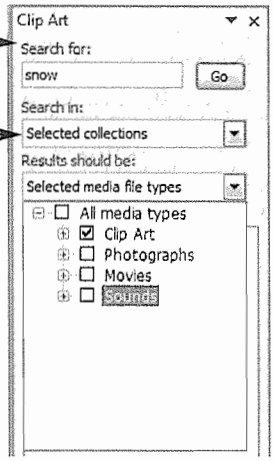
Open the file Ch_10_Task_10b.
Add a suitable image from clip art, from a scanner, from a digital camera and from the file SNOWBALL.JPG.

Importing an image from clip art

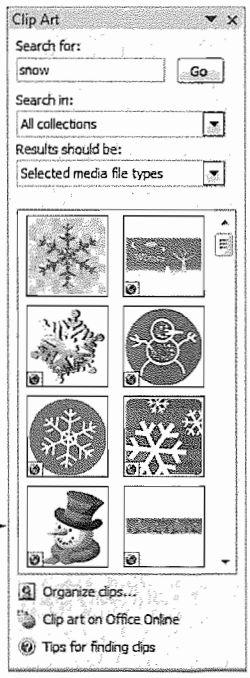
To import an image from clip art, select the **Insert** tab and click on the **Clip Art** icon.



This will open the **Clip Art** pane to the right of the document. As there are thousands of clip-art images available in some packages it is sensible to search for images of a type to see what is available. In this case the article is about snow, so you can add this as your search string in the **Search for:** box. In the **Search in:** box, choose from the drop-down list where you wish to search for the images: it could be on the local machine or via a web search. This may also depend upon the network settings of your system. Local searches will result in fewer images being found (when I tried this search I only obtained one result), but searching **Everywhere** may take a long time depending upon your network connection speeds. You must also define the type of resource that you wish to include. This is found in the **Results should be:** box which opens a drop-down menu. In this case you want clip art, so ensure that only this tick box is selected. Click on Go.



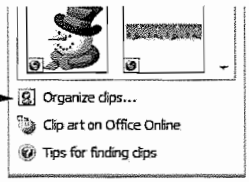
The results of the search may look like this.



Move your cursor to the end of the document and double click the left mouse button on the image you want to place on the page. You will manipulate this image later in the chapter.

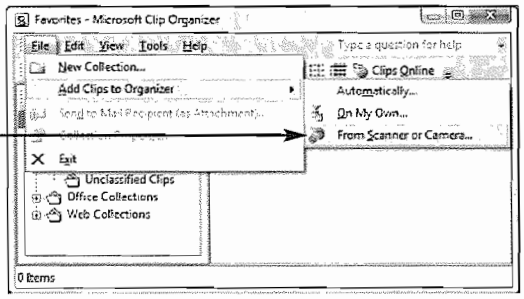
Importing an image using a scanner

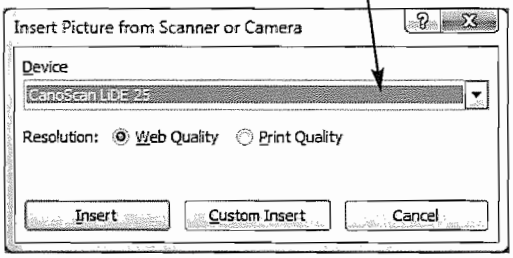
Images can be scanned and added to your clip-art collection. Select the **Insert** tab and click on the **Clip Art** icon to open the **Clip Art** pane. Click on the **Organize clips...** icon.

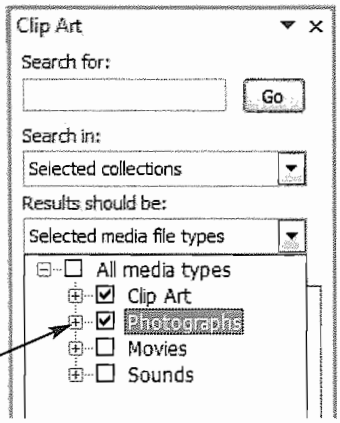


This opens the **Microsoft Clip Organizer** window. Select the **File** menu, followed by **Add Clips to Organizer**, then **From Scanner or Camera...**.

This will open the **Insert Picture from Scanner or Camera** window. Select the scanner in the **Device** box and click on Insert. Scan the image – the instructions for this will vary depending upon the scanner software.

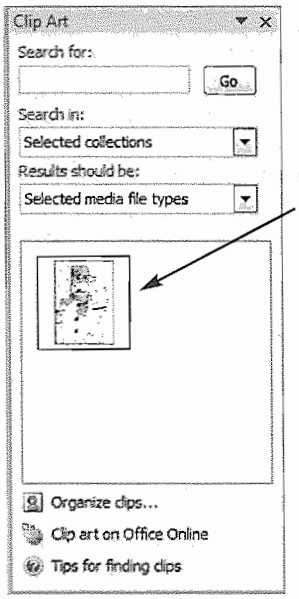






The image you have scanned will be added to the images stored on the local machine and can be obtained from the **Clip Art** pane. Remove the search string from the **Search for:** box. In the **Search in:** section, use the drop-down list and select only the option for **My Collections**.

In the **Results should be:** box, tick the boxes for **Clip Art** and **Photographs**. When these options have been selected click on Insert. The scanned image, plus any others stored locally, will appear like this.

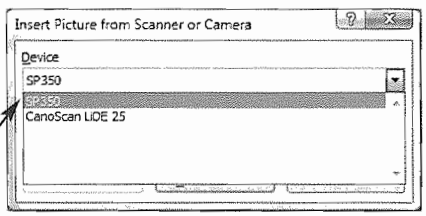


Double click the left mouse button on the scanned image to place it on the page.

Importing an image using a digital camera

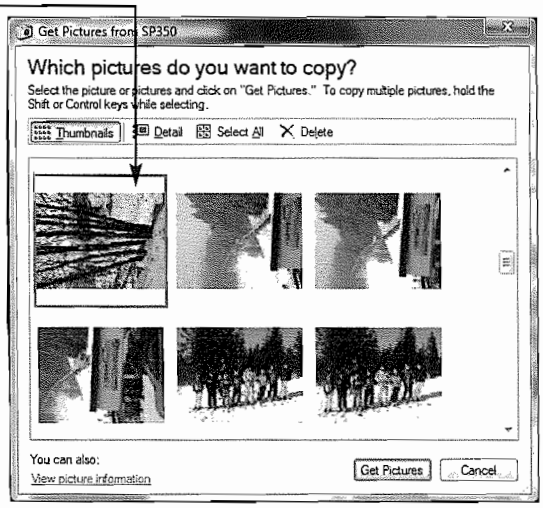
You can import an image from a digital camera in one of two ways. Both methods require you to attach the digital camera to the PC, turn on the camera and, if required, select the PC setting on the camera. All cameras are slightly different in this respect.

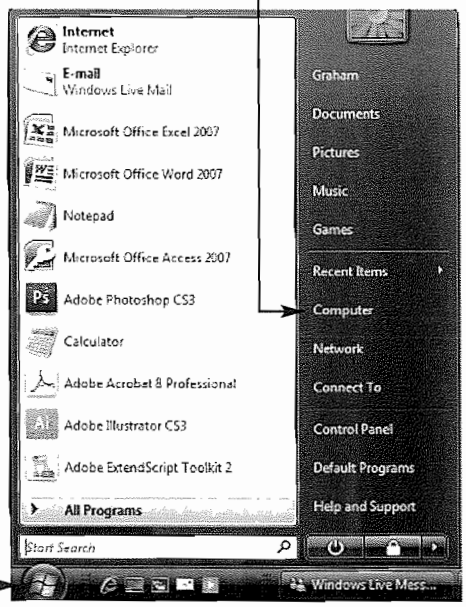
The first method is similar to using the scanner, and adds an image or images from the camera into the clip-art images stored on the local machine. As for the scanner, select the **Clip Art** pane, the **Organize clips...** icon, then **File**, **Add Clips to Organizer** and **From Scanner or Camera...**. Choose the camera from the available options like this.



Click on the Custom Insert button to open the **Get Pictures from...** window. Depending upon your camera, you may need to find the correct folder. When you have found this you will see all the pictures available on the camera. Click the left mouse button to select an image or use the left mouse button and <Shift> or <Ctrl> keys to select multiple images. When you have chosen the images that you want, click on Get Pictures. This image will now be available as clip art, like the image scanned earlier in this section.

The second method is to attach the digital camera to the PC and click on the **Start** button, followed by **Computer**.

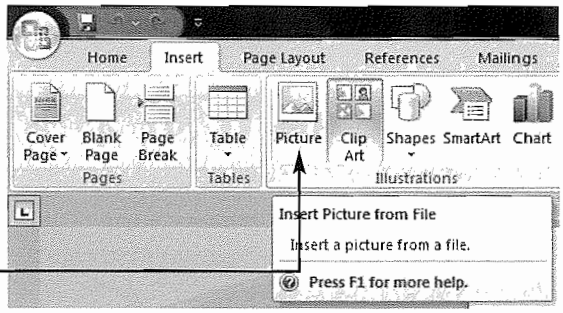


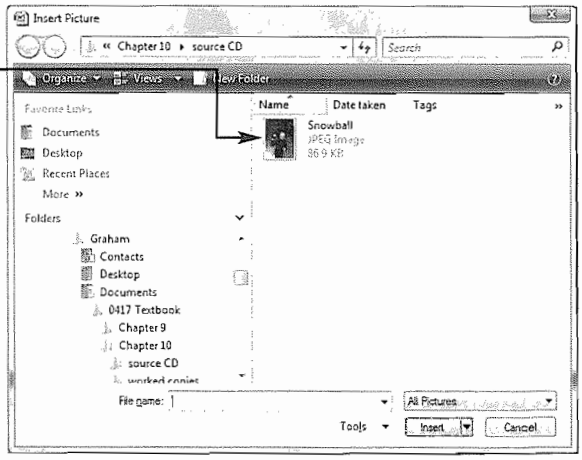


This opens the **Computer** window and allows you to browse the available storage devices. Select the **Removable Disk** option (it may have the camera name here). Copy the image file and paste it into the word-processed document.

Importing an image provided for the task

Select the **Insert** tab, followed by **Picture**. This opens the **Insert Picture** window. Browse through the folders and files until you locate the file SNOWBALL.JPG.





Click the left mouse button on this file followed by the Insert button. This will insert the image into the document. Save the document with a new filename.

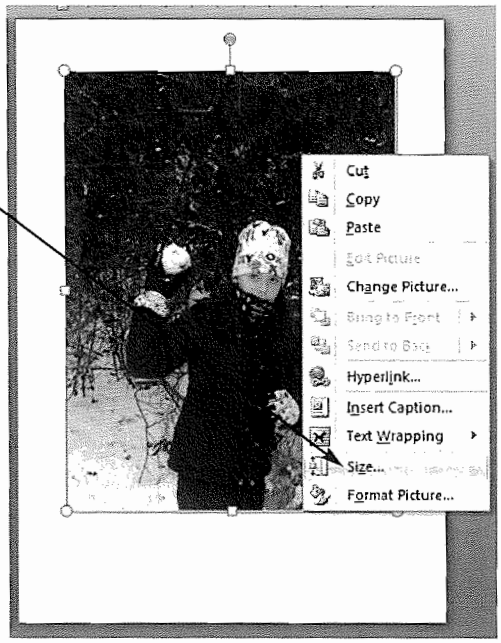
You will notice that the images have just been placed at the end of the document. These will now need manipulating so that they become a part of the document, rather than just appended to the end.

10.6 Resizing images

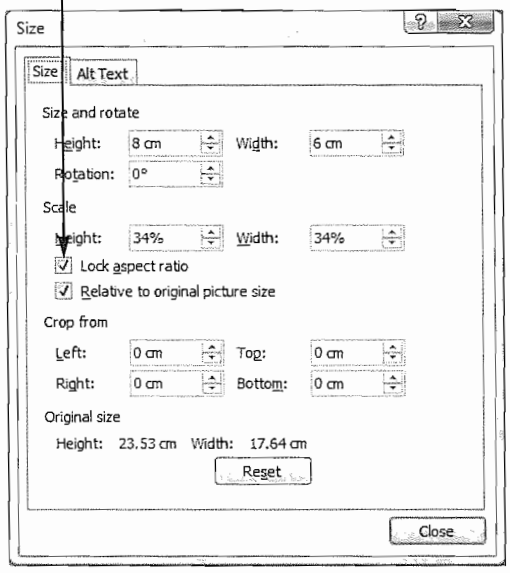
Task 10d

Open the file Ch_10_Task_10c.
Resize the image SNOWBALL.JPG to 8 centimetres high and maintain its aspect ratio. Place this at the top right of the first paragraph.
Resize the clip-art image to 2.8 centimetres high and 2 centimetres wide. Place this image at the top left of the second paragraph. Ensure that the text wraps around both of these images.
Place the scanned image to the right of the table, aligned to the right margin. Resize this image if needed.
Place the image from the digital camera to the bottom left of the page. Crop the image to remove the top 25 per cent of it. Ensure that all the text and images fit on a single page.

Find the image SNOWBALL.JPG in your document. To obtain a drop-down menu, right click with the mouse on this image. From this menu select the **Size...** option. This opens the **Size** window.



The task instructs you to resize the image maintaining its aspect ratio. This means to keep the height and width in the same proportions as the original image, usually to ensure that you do not distort it. To do this, ensure that the two tick boxes related to the aspect ratio are both selected.



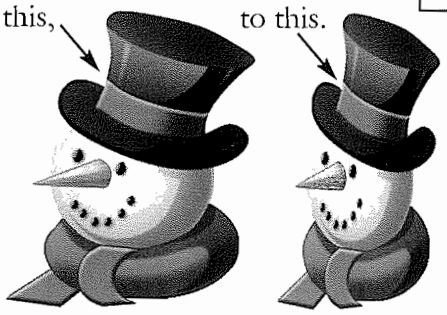
Change the **Height:** of the image to 8 centimetres and click on Close.

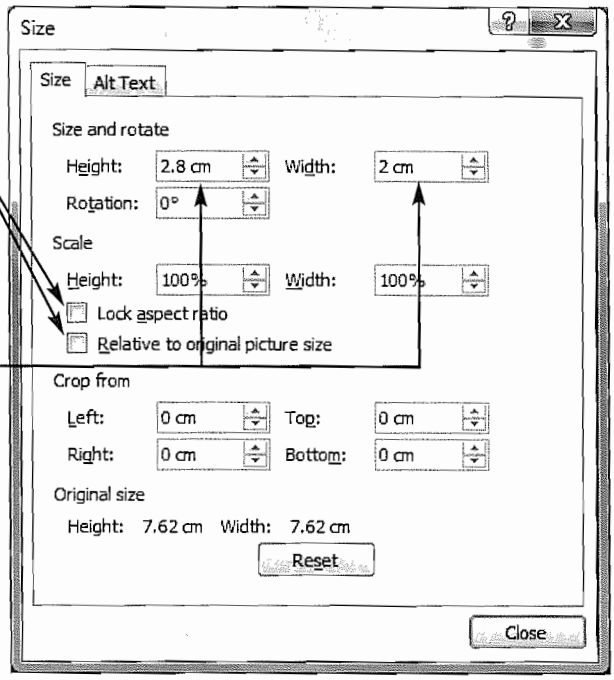
Use a similar method to resize the clip-art image to 2.8 centimetres high by 2 centimetres wide. Select the clip-art image and open the **Size** window for that image. In this case different lengths and widths have been specified, but you have not been instructed to crop the image.

This means that you will probably distort the image from its original proportions. To do this, ensure that both of the aspect ratio tick boxes have their ticks removed.

Use the **Height:** box to change this setting to 2.8 centimetres and the **Width:** box to 2 centimetres.

This will change the proportions of the image from this, to this.





Hint

If evidence of an image size or the aspect ratio is required for a practical examination, you can use screenshot evidence of this window.

Notice how the second image is slightly thinner but the same height. This task is continued in the next section.

10.7 Wrapping text around images

Task 10d requires you to place the resized SNOWBALL.JPG image at the top right of the first paragraph. A question like this would expect you to align the image to the margins and to the top of the paragraph, and there is a further instruction to warp the text around the image. It is often wise to set the text wrapping first, then place the image. To set the text wrapping of the image, right click with the mouse on this image. From the drop-down menu, select the **Text Wrapping** option.

You get a sub-menu with the layout options. Useful ones include:

1. **In Line with Text**
   This places the image as an in-line graphic and is treated as a text character within a line of text. It will move with the text surrounding it if new text is inserted or deleted.

2 **Square**
   This places the image on the page and the text wraps (flows) around it. Use **More Layout Options...** to specify the type of wrapping that you require.

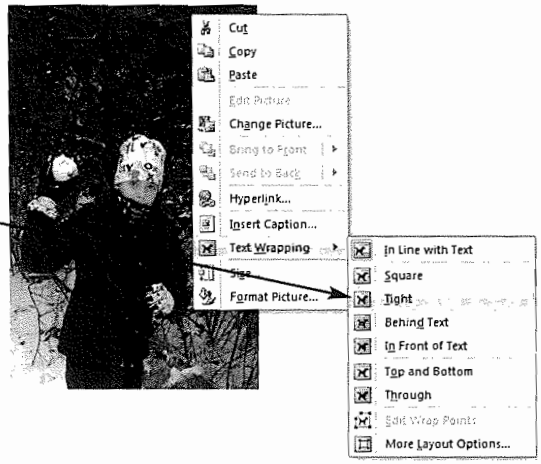
3 **Tight**
   This places the image on the page and the text wraps (flows) around it, like **Square**, but you cannot control the distance of the text from the image for the top and bottom settings, although you can to the left and right, using **More Layout Options...**.

4 **Behind Text**
   This places the image behind the text. It can be used to set a background image in a document.

5 **In Front of Text**
This places an image over the top of the text.

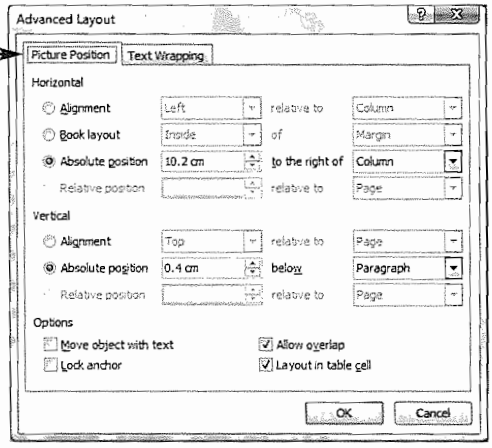
6 **Top and Bottom**
This places the image with the text above and below the image, but not wrapped to the side.

7 **More Layout Options**
This can be used to give more options to the selected layout types above. For example: if a **Square** layout is selected you can specify where you wish to flow the text around the image and the distance of the text from the image on each side. This option also allows you to control the positioning of the image on the page.

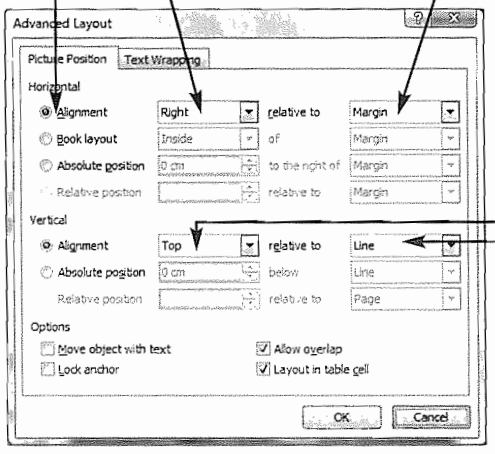


For this task, set the **Text Wrapping** of the image to **Tight** using the sub-menu.

To move and place the image, click and hold the left mouse button on the image and drag it to the top right corner of the first paragraph. When you have roughly placed this image, right click on the image again. Select the **Text Wrapping** option, followed by **More Layout Options...**, to get the **Advanced Layout** window. Click on the **Picture Position** tab.



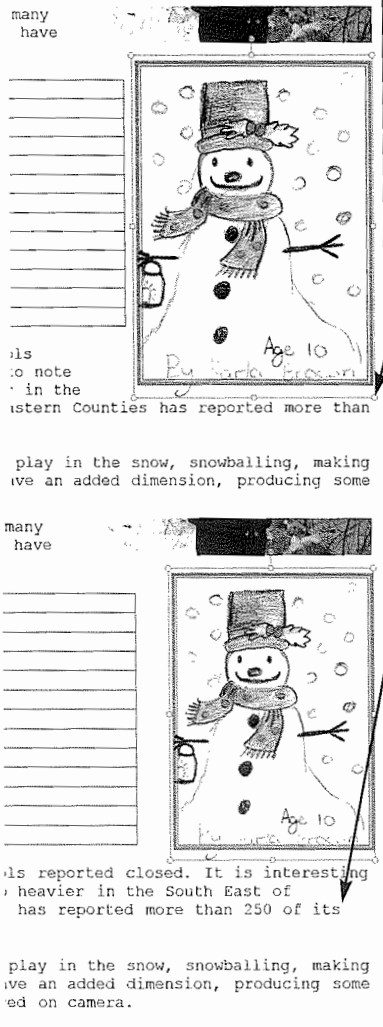
In the practical examinations you will be expected to place images precisely. To align the text to the right margin, in the **Horizontal** section, first select the **Alignment** radio button and then set the image **Right** aligned relative to the **Margin**.



To align the image to the top line of the paragraph, in the **Vertical** section, select the **Alignment** radio button and then **Top** relative to the **Line**. To set the position, click on OK. Check that this has worked correctly. If not, this is usually due to the image being placed with too little precision when it was dragged and dropped. Try dragging and dropping the image again and repeat the process.

Repeat both procedures for the clip-art image, wrapping the text using **Tight**, and placing the image with a **Horizontal** alignment of **Left** relative to the **Margin** and a **Vertical** alignment of **Top** relative to the **Line**.

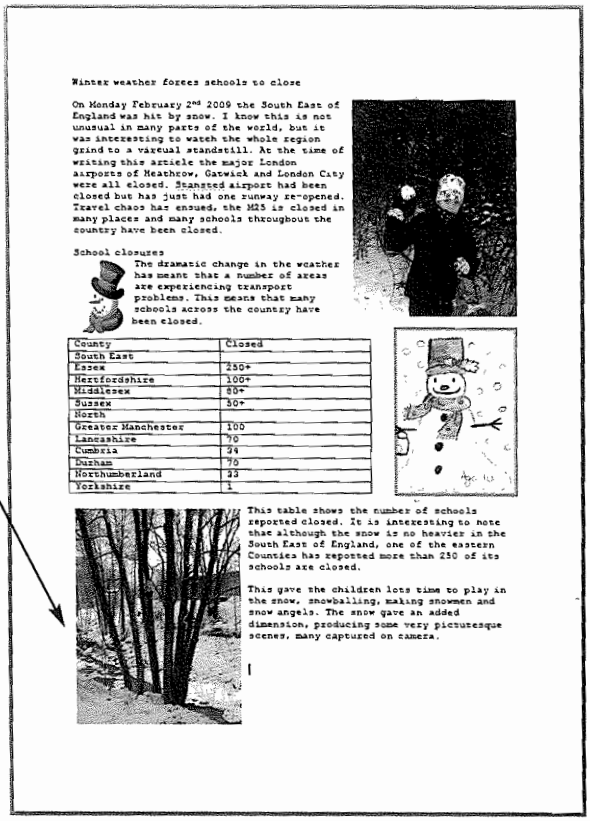
To place the scanned image to the right of the table, aligned to the right margin, follow the same procedures as above, set the wrapping and align the image with the right margin. The image is still too large for the space; no size has been specified, but it needs resizing without changing its aspect ratio. Use the drag handle in the corner to resize the image (do not use the drag handles in the middle, as they will affect the aspect ratio).



The resizing has been completed so that the paragraph below the scanned image does not have to wrap around it. This has been done to ensure that the final instruction within this task to 'Ensure that all the text and images fit on a single page' can be completed.

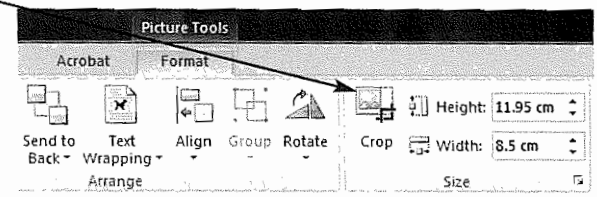
The image from the digital camera may need to be rotated before it can be placed on the page or resized. Click the left mouse button on the image to select it. You will notice a rotate handle as well as the drag handles used to resize the previous image. Hold down the Shift key, then click and hold the rotate handle and drag it in a clockwise direction (like the arrow). When the image has rotated through 90 degrees (so that it is upright) let go of the mouse button.

The rotated image will need resizing to fit the available space. It is recommended that you resize the image to a smaller size than required at this stage. This image should have the text wrapping set to **Tight**, and placed with a **Horizontal** alignment of **Left** relative to the **Margin** and a **Vertical** alignment of **Bottom** relative to the **Bottom Margin**. Then resize the image to fit the available space. The page should look like this. This task is continued in the next section.

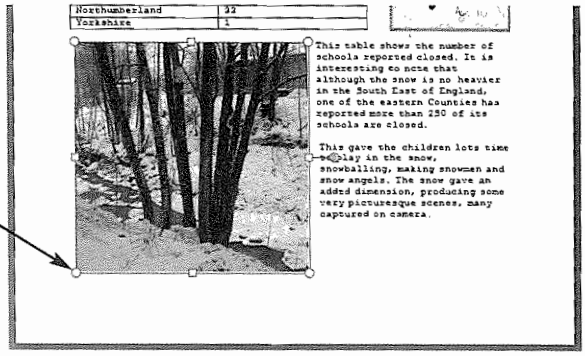


10.8 Cropping images

To crop the image from the digital camera, click the left mouse button on the image, then on the **Format** tab (which should have the text **Picture Tools** displayed above it) at the top of the window. From the **Size** section of this toolbar click on the **Crop** icon.

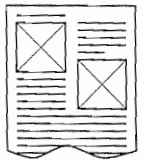


This will change the drag handles used to resize the picture to crop handles, which are used to cut off a portion of the image. Drag the top handle down so that approximately the top 25 per cent (a quarter) of the picture has been removed. To resize the image again, you must click your left mouse button back on the text, then on the image, so that the crop tool has been removed and use the drag handles to resize the image.



Activity 10b

1 Open the file saved in Activity 10a. Add the image TREES.JPG (from the CD) and rotate it through 180 degrees. Resize it to 7 centimetres wide, maintaining its aspect ratio. Place it at the top left of the first paragraph. Ensure that the text wraps around this image.
2 Scan the image SNOWANGEL. Place and resize this image at the start of the second paragraph, so that it left and right aligns with the text wrapped around the first image like this:



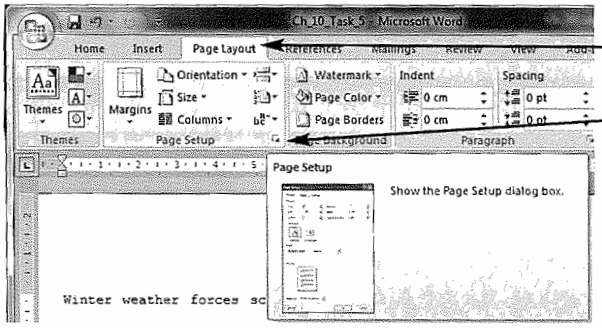
3 Crop the top and bottom of the SNOWANGEL image so that the child is within 5 millimetres of the edge of the image.
4 Add an image of a car or train from clip art and place this at the bottom of page 1 so that it moves the table onto page 2.
5 Add a suitable image from a digital camera of a car, train or snow and place this in an appropriate place on page 2.
6 Save and print this document.

10.9 Formatting pages

In the practical examinations, you may be presented with documents with different page layouts and given instructions to reformat them. Do not assume that a document is already set as specified. If it is in text (.txt) format, it will use the default settings of your word processor. If it is opened in rich text format (.rtf) or was saved as a *Word* document, it will keep the settings used to save the file.

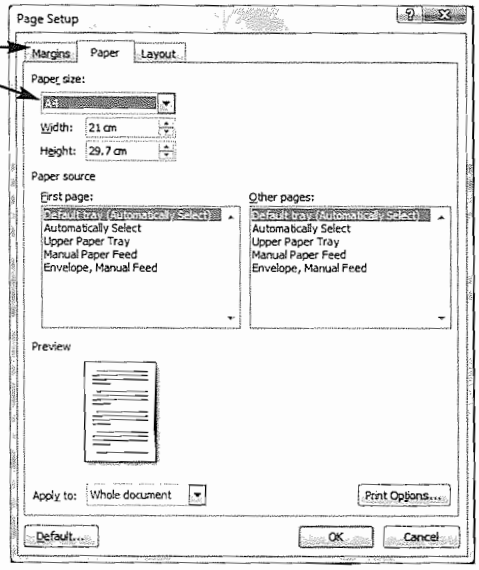
Task 10e

Open the file saved in Task 10b.
Change the page size to A5 and the orientation to landscape. Set the top and bottom margins to 3 centimetres and the left and right margins to 3.5 centimetres.
Save the file with a new name and print the document.



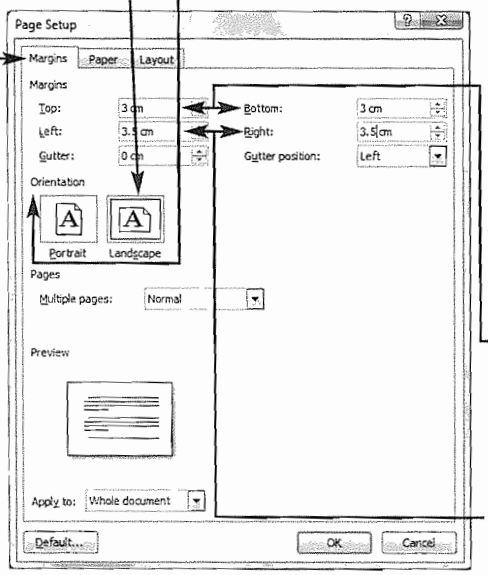
Open the file saved in Task 10b and select the **Page Layout** tab. Double click the left mouse button on the icon at the bottom right corner of the box, to open the **Page Setup** window.

This window can be used to change the page size, orientation (to make the page tall or wide) and the page margins. To change the paper size, select the **Paper** tab. The **Paper size:** can be selected from the drop-down list. For this task, select A5 from this list.



To change the page orientation, select the **Margins** tab.

Find the **Orientation** section of the window. Click the left mouse button on the **Landscape** icon to change from portrait to landscape.



To set the top and bottom margins to 3 centimetres, select the **Margins** section, then either; highlight the text within the **Top:** and **Bottom:** boxes and type in the new values, or use the scroll handles to change the values in each of the boxes.

Change the left and right margins to 3.5 centimetres using a similar method in the **Left:** and **Right:** boxes. Click on OK.

If the document is to be part of a bound book, a **gutter** may be needed. This is an area outside the margins that is used to bind the book together. If you need to use a gutter, this can also be set in the same way using the **Margins** section of the window. The gutter can be placed to the left or top of the page, depending upon the type of binding to be used. Save the document.

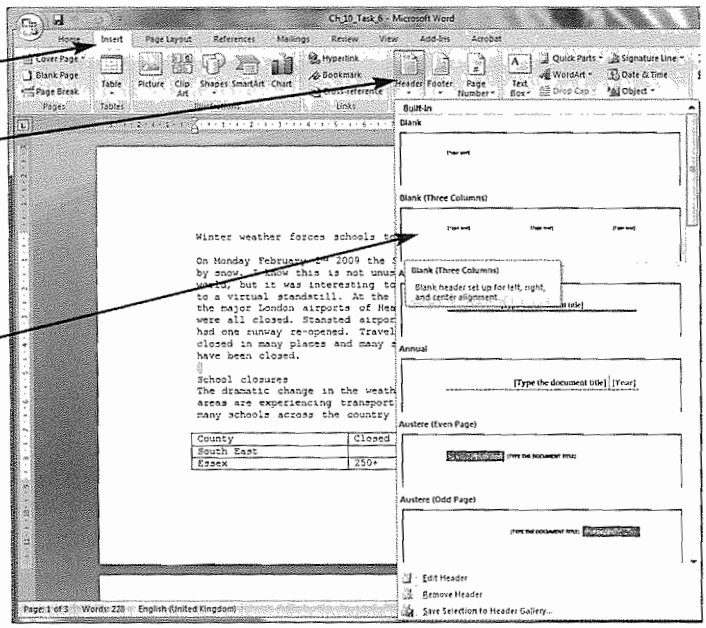
10.10 Using headers and footers

A **header** is the area of a document between the top of the page and the top margin. A **footer** is the area of a document between the bottom of the page and the bottom margin. You can insert text or graphics into headers and footers. This might include the author's name, the document's filename, page numbering, or even a company logo. Headers and footers can be found in many printed documents, including those that have been word processed or desktop published, and in presentations, reports from spreadsheets and databases and in **webpages**.

Task 10f

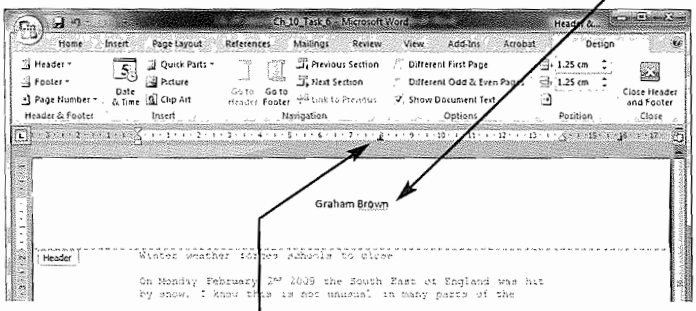
Open the file saved in Task 10e.
Place your name in the centre of the header. Place the date and time on the left, an automated page number in the centre and the filename on the right in the footer.
Save the file with a new name.

To use the document header or footer select the **Insert** tab. In the **Header & Footer** section click on the **Header** icon. This offers a range of built in header styles; simple **Blank** settings are all that should be required for the practical examinations. If you select the **Blank (Three Columns)** option, this will allow you to put text on the left, in the centre and on the right within the header. This moves the cursor into the header and changes the toolbar to give you options for the header, like changing the position of the header relative to the edge of the page.



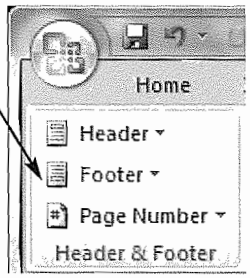
For Task 10f you are instructed to place your name in the centre of the header. Move the cursor over the centre placeholder that says [**Type Text**] and type in your name.

Your text will replace the placeholder. For this task you were not instructed to place anything in the left or right placeholders. These must be deleted or you may be penalised in the examination. Select each placeholder in turn and press the <Delete> key. The header should now look similar to this.

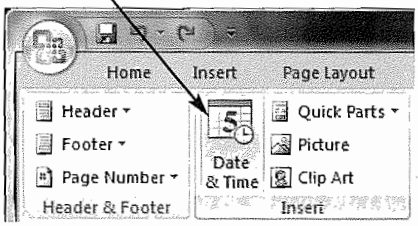


To set up the page footer, do *not* click on the **Go To Footer** icon. Although this takes you into the footer, it neither sets up the placeholders nor correctly positions the tab stops for the centre and right aligned text. Whilst this works fine for a standard document, if you have changed the margin settings of a document, as in Task 10e, the tab stops do not align with the margins as shown here. You can see in this example that the centre tab stop is not set to 7 centimetres which would be the centre of this page with these margin settings.

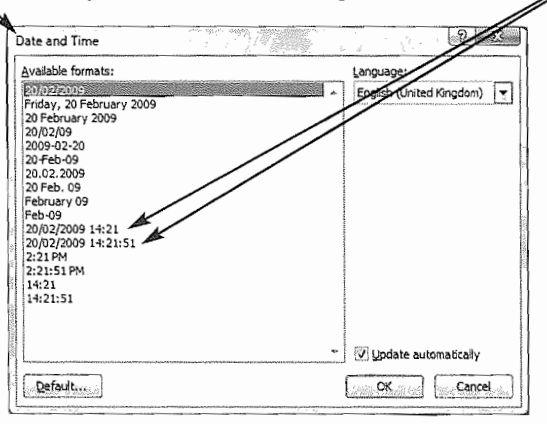
To set up the page footer, click on the **Footer** icon on the **Header & Footer** section of the toolbar and then the **Blank (Three Columns)** option. This will allow you to set all three areas of the footer.



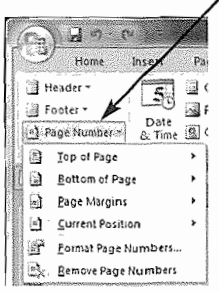
In Task 10f you are instructed to place the date and time on the left in the footer. Click the left mouse button on the left placeholder to highlight it. Then click on the **Date & Time** icon on the toolbar.



This will open the **Date and Time** window. In this task, the format of the date and time has not been specified so you can select either of the options that shows both the date and the time. Click the left mouse button on the format that you choose. Make sure that if you wish the date and time to update automatically, this tick box is completed before clicking on OK.



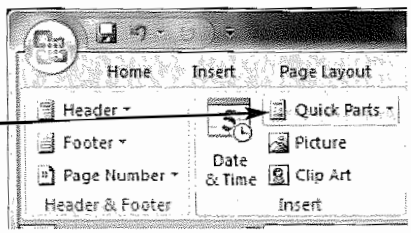
You were also instructed to place an automated page number in the centre of the footer. Click the left mouse button on the centre placeholder, then click on the **Page Number** icon from the toolbar. This gives you a drop-down menu, from which you need to select the option for **Current Position**. Select the format for the page numbering; again, in this task the format of the numbering has not been specified so you can select whichever option you choose. Check carefully that the automated page numbering has not placed an extra carriage return into the footer; if it has remove this using the <←Backspace> key.



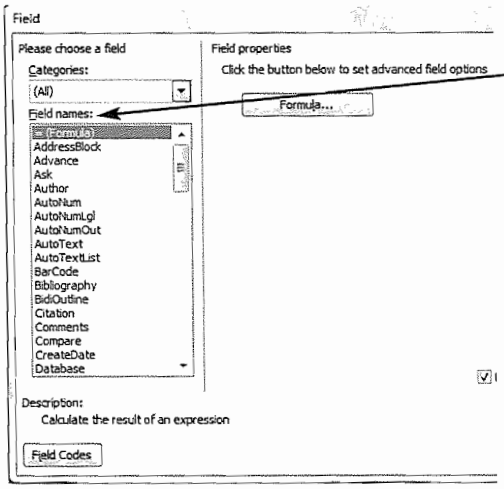
Hint

If you are not sure whether a carriage return exists in the text, header or footer, select the **Home** tab on the toolbar, then the **Show/Hide** ¶ icon. Carriage returns will appear in the document as ¶.

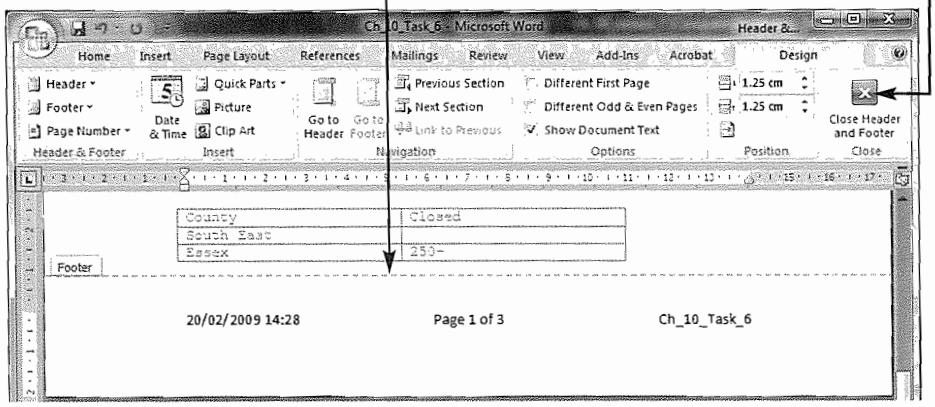
You were also instructed to place the document's filename on the right in the footer. Click the left mouse button on the right placeholder, then click on the **Quick Parts** icon on the toolbar.



This will allow you to select a number of automated functions, most of which are beyond the scope of this book. Select **Field...** to open the **Field** window. In the **Field names:** box, scroll down through the list and select **FileName**. Select the **Format:** for the filename from the list of available options. If the full path of the filename is required select the **Add path to filename** tick box before clicking on OK. The completed footer should look similar to this.



To exit from the header or footer back into the document, either click on the **Close Header and Footer** icon, or double click the left mouse button on the body text of the document. Save the document.



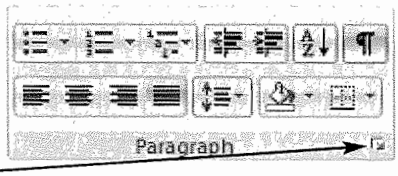
Activity 10c

Open the file ACTIVITY3.RTF. Change the page size to A4 and the orientation to portrait. Set all the margins to 4 centimetres and remove the gutter. Place the date on the left, the filename in the centre and the time on the right in the header. Place your name on the left and an automated page number on the right in the footer. Ensure that the header and footer are 2 centimetres from the top and bottom of the page respectively. Save and print the document.

10.11 Widows and orphans

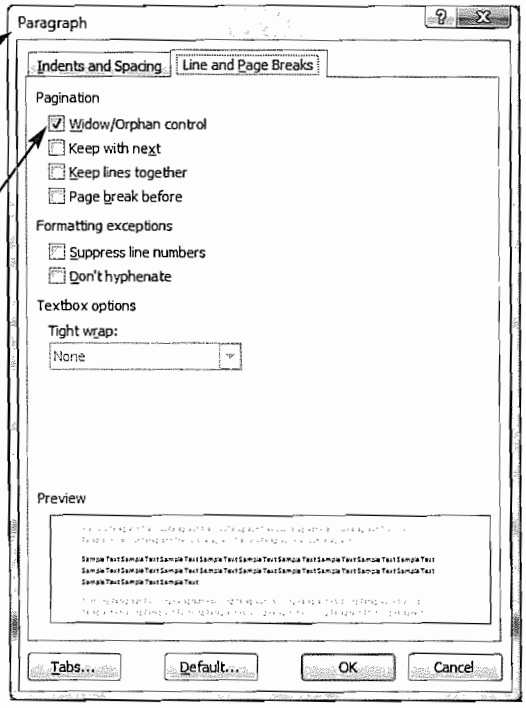
If you start a paragraph of text on one page but there is not enough room on the page to get the last line typed in, the single line of text which appears at the top of the next page is called a **widow**. Similarly, sometimes you start a paragraph at the bottom of a page but you can only type in one line before the rest of the text goes onto the next page. The first line of the paragraph at the bottom of the page is called

an **orphan**. These should be avoided when producing a document and you are likely to be penalised if you include these in any submission for the practical examinations. They can be manually avoided by inserting a **Page Break**, which does not show the reader that you have forced the page break at this point. For more information on breaks, refer to Section 10.12.



You can set up *Word* to automatically avoid widows and orphans. To do this select the **Page Layout** tab, then in the **Paragraph** section click on the expand icon to open the **Paragraph** window.

Now select the **Line and Page Breaks** tab so that the window looks like this. To get *Word* to automatically avoid widows and orphans, select the **Widow/Orphan control** tick box and click on OK.



10.12 Using page, section and column breaks

Breaks can be used within a document to force text onto a new page or into the next column (if columns are being used), or to define areas with different layout, for example where part of a document is formatted in landscape orientation and part is in portrait. For the practical examinations you will only need to use these effects:

1 Page break

This forces the text onto the start of a new page, leaving **white space** at the end of the previous page. It is particularly useful for removing widows and orphans from your document, although *Word* can be set up to do this for you (see Section 10.11).

2 Column break

This forces the text into the top of the next available column, which may be on the same page or may be on the next page.

3 Section break

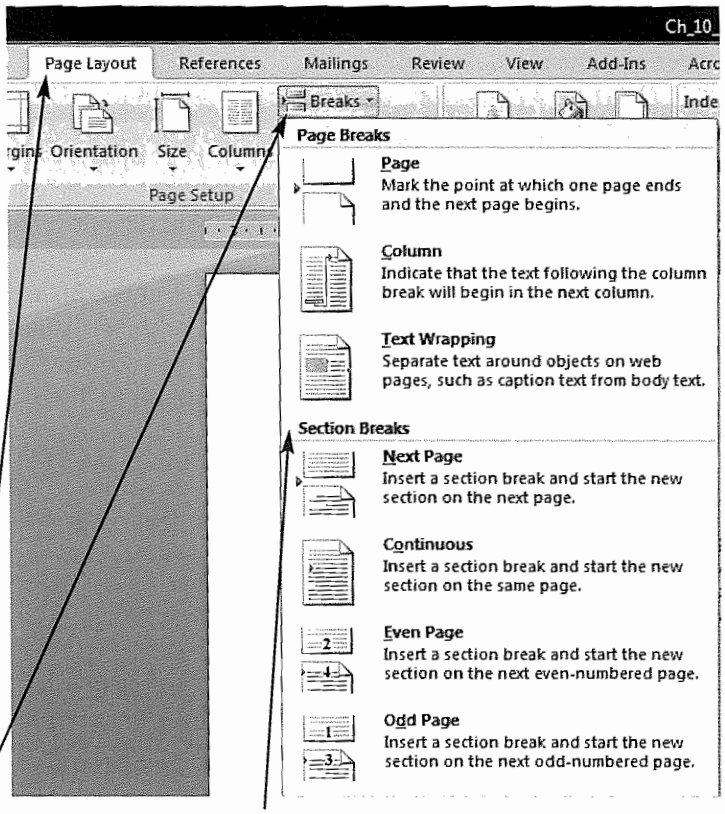
A section break is used to split areas of a document with different layouts. There are two types of section break: one forces a page break as well as the change in layout and the other is a continuous break, that allows different layouts on the same page.

Task 10g

Open the file saved in Task 10f.
Add the text 'Winter wonderland or woe' as a new title at the start of the document. Keep the two titles on the first page of the document. Set the orientation of the first page to portrait and the rest of the document to landscape. Set all of the body text except the table into two columns, with a 2 centimetre spacing and vertical line between the columns.
Save the file with a new name.

Open the file saved in Task 10f and add the text 'Winter wonderland or woe' to the start of the document as a new title.

Move the cursor to the place where the first break needs to be inserted. This will be just before the text 'On Monday ...'. Because this break will be the separator between two different types of layout (page 1 being portrait and page 2 onwards being landscape), a section break for a new page needs inserting rather than just a page break. To do this, select the **Page Layout** tab and click on the **Breaks** icon.



This drop-down list will appear. Select the **Section Break** option for the **Next Page**.

As the document is currently in landscape orientation, move the cursor to page 1, the section that needs to be changed to portrait orientation. Then select the **Page Layout** tab again, followed by the **Orientation** icon and click on **Portrait**. You will notice that the word processor has only changed the orientation of this page (because you inserted the section break) and that all of the header and footer settings have been automatically amended for the new layout of this page. This task is continued in the next section.

Hint

If you select the **Home** tab on the Toolbar and click on the **Show/Hide** icon, the section break will be visible like this:

```
¶
Winter·weather·forces·schools·to·close¶
¶.....Section Break (Next Page).....
```

10.13 Using columns

Columns can be used to give a layout similar to that found in a newspaper and you may be required to format a document, or part of a document into a number of columns. If you are going to have different column settings for different parts of the document, you must decide where you are going to split the document into the different sections. This information is often given to you in the examination questions.

For Task 10g you need to add two more section breaks to the document, so that the body text and the table can have different layouts. These section breaks need to be at the start and end of the table. Because the text and table do not need to be on different pages you need to set these as continuous section breaks. Move the cursor to the place where you want each break inserted (i.e. before and after the table), then in the **Page Layout** tab click on the **Breaks** icon, followed by the **Section Breaks** option